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Nonpoint Source Pollution Information Guide

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NONPOINT SOURCE POLLUTION

INFORMATION GUIDE

AUGUST 1985

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U. S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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This document contains information identifying eight Federal agencies, and several sub-units within each of them that are involved in environmental impacts of nonpoint source pollution. Complete mail addresses and telephone numbers are included for each organizational unit, along with a brief description of the specific area of concern. This resource will be of value in directing specific questions on nonpoint source pollution to the appropriate agency.

Also included is a listing of published resources, either in print or in computer files, an annotated bibliography which includes abstracts of recent publications, and an appendix listing database vendor addresses.

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Watersheds
Water pollution
Water resources
Sedimentation
Storms
Regional planning
Urban planning
Civil Engineering

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Runoff
Streamflow
Stream pollution
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Snowment
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Water quality
Sediments
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Suspended solids
Storm Drains
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DISCLAIMER

This report has been reviewed by the U. S. Environmental Protection Agency and approved for release. Approval does not signify that the contents necessarily reflect any policies or decisions of the U. S. Environmental Protection Agency or any of its offices, grantees, contractors, or subcontractors. No mention of any commercially available information systems or the companies offering them should be construed as an endorsement by the U.S. Environmental Protection Agency or any of its offices, grantees, contractors, or subcontractors.

FOREWORD

The U.S. Environmental Protection Agency was created because of increasing public and government concern about environmental quality. The complexity of our environment and the interplay among its components require concentrated and integrated approaches to pollution problems.

The possible deleterious water quality effects of nonpoint sources were recognized by the Water Pollution Control Act Amendments of 1972. As point source pollution abatement efforts succeed in reducing the pollutants being discharged from municipal and industrial sources, the role of various nonpoint sources of pollution in preventing the attainment of water quality objectives is coming under increasing scrutiny. Although there are no doubt many receiving water bodies where the effects of nonpoint source pollution are minimal, there are many others where nonpoint sources are contributing to an impairment or denial of designated uses and where the restoration or attainment of such uses will not be possible without some degree of nonpoint source control.

At the present time, information about the nature and characteristics of pollution discharged from various types of nonpoint sources and its effects on receiving waters is widely scattered and diffuse. Yet, those involved in water quality management, whether they be engineers, scientists, planners, policy makers, or public or private officials, need access to nonpoint source information if they are to discharge their responsibilities in a reasonable and effective manner. To help meet this need, as a part of its technical assistance program to states and localities, the Office of Water has prepared this Nonpoint Source Pollution Information Guide. It will be updated annually to reflect the growing body of data and information becoming available in this field.

PREFACE

This Nonpoint Source Pollution Information Guide is divided into three sections. The first section provides a summary of the environmental information services of the U.S. Government. The information is alphabetically organized by federal agency as follows:

- Department of Agriculture
- Department of Commerce
- Department of Defense
- Department of Health and Human Services
- Department of the Interior
- Environmental Protection Agency
- Library of Congress
- National Science Foundation

In every case, both a complete mailing address as well as a telephone number have been provided.

The second section deals with published resources about the environment and is divided into six primary categories as follows:

- Abstract and Index Journals and other Guides to the Literature
- Data Bases
- Recent Bibliographies and Reviews
- Handbooks, Manuals, and Catalogs
- Maps, Drawings, and Other Graphic Information
- Directories

Entries for abstract and index journals give the name, dates of publication, and descriptions. Entries for data bases give the name, the types of data or the dates of coverage for bibliographic files, descriptions, and availability.

The third section is an annotated bibliography consisting of a somewhat subjective collection of abstracts of recent publications dealing with matters of interest to those concerned with nonpoint source pollution. These abstracts have been grouped into seventeen categories as follows:

- Rainfall/Runoff
- Erosion/Sediment
- Heavy Metals/Sediment Binding
- Nutrients
- Nitrate/Groundwater
- Micro-organisms
- Urban Runoff/Combined Sewer Overflow (URO/CSO)
- Agriculture
- Silviculture
- Mining
- Highway Runoff
- Best Management Practices (BMPs)
- Biological
- Sampling/Monitoring
- Data Analysis/Modeling
- Policy
- Miscellaneous

Obviously, many of the publications reviewed in this guide could fall into more than one category. For example, a study might have both characterized runoff from a particular land use/land cover as well as the performance of some best management practice. In such cases, the publications were placed in the category that the present author believed best suited the predominant theme or finding of the publication in question. In other instances, some possible categories, such as airport runoff, although extant in the literature, are so sparsely represented that a separate category did not seem justified. Such citations were placed in the closest of the seventeen final categories chosen. Thus, publications on airport runoff, for example, appear in the URO/CSO category.

An appendix to this Nonpoint Source Pollution Information Guide addresses information utilities, data-base vendors, and value-added networks. Many of the computerized data bases that the government compiles are being made publicly available through sale or lease to commercial enterprises. Others, whose commercial appeal is less certain, are being made directly available on government computers. There are some data bases that are not being made directly available at all; only mediated access, if any, is being allowed to them. In the main body of this information guide are listed numerous data bases that contain government-supplied information and that can be accessed through commercial data-base vendors. Their names and addresses are given in the appendix. These vendors can be contacted directly to obtain more information about the data bases they carry, the services they offer, the equipment needed to utilize their systems, the telecommunications networks they employ, and the charges for their services. No mention of any of these commercially available systems or the companies offering them should be construed as an endorsement by the U. S. Environmental Protection Agency or any of its offices, grantees, contractors, or subcontractors.

ACKNOWLEDGEMENTS

This Nonpoint Source Pollution Information Guide has been assembled for the Nonpoint Sources Branch, Office of Water, U. S. Environmental Protection Agency under contract number 68-01-6998 by a team assembled by Woodward-Clyde Consultants. The principal author is Dr. Philip E. Shelley of EG&G Washington Analytical Services Center, Inc.

Much of the material presented herein has previously appeared in other publications of the U. S. Government. Consequently, the role of the principal author has been largely one of review and selection for inclusion, rather than original writing. The abstracts of publications appearing in the annotated bibliography section of this guide have been taken from three major sources:

(1) Original author's abstracts;

(2) Specially written abstracts prepared for the most part by USGS personnel and appearing in *Selected Water Resources Abstracts*; and

(3) Specially written abstracts primarily prepared by personnel from DOE's Office of Scientific and Technical Information and appearing in *Energy and the Environment*, A Current Awareness Journal.

Material in the section of this guide on sources of information, compiled in print or in computer files, has been taken from numerous U. S. Governmental sources, chief among which is *Gaining Access to U. S. Government Information on the Environment and Natural Resources*, prepared under the sponsorship of the Assistant Secretary for Policy, Safety, and the Environment, U.S. Department of Energy and the Council on Environmental Quality, Executive Office of the President.

TABLE OF CONTENTS

Section Page

Foreword iii
Preface iv
Acknowledgements vi

1 ENVIRONMENTAL INFORMATION SERVICES OF THE U. S. GOVERNMENT 1-1
  Department of Agriculture 1-3
  Department of Commerce 1-7
  Department of Defense 1-11
  Department of Health and Human Services 1-13
  Department of the Interior 1-15
  Environmental Protection Agency 1-17
  Library of Congress 1-19
  National Service Foundation 1-21

2 PUBLISHED RESOURCES 2-1
  Abstract and Index Journals 2-3
  Data Bases 2-7
  Recent Bibliographies and Reviews 2-11
  Handbooks, Manuals, and Catalogs 2-15
  Maps, Drawings, and Other Graphic Information 2-19
  Directories 2-21

3 ANNOTATED BIBLIOGRAPHY 3-1
  Rainfall/Runoff 3-3
  Erosion/Sediment 3-21
  Heavy Metals/Sediment Binding 3-35
  Nutrients 3-49
  Nitrate/Groundwater 3-65
  Micro-Organisms 3-75
  URO/CSO 3-83
  Agriculture 3-103
  Silviculture 3-127
  Mining 3-135
  Highway Runoff 3-145
  Best Management Practices (BMPs) 3-151
  Biological 3-159
  Sampling/Monitoring 3-167
  Data Analysis/Modeling 3-177
  Policy 3-197
  Miscellaneous 3-201

APPENDIX A-1

SECTION 1

ENVIRONMENTAL INFORMATION SERVICES OF THE U. S. GOVERNMENT

The primary source of printed and microfiche environmental information generated by the U. S. Government and its contractors is the National Technical Information Service (NTIS), with the U. S. Government Printing Office (GPO) offering certain items for sale that are believed to be of widespread interest. A lesser known fact is that GPO operates a depositor-library program that places copies of government publications at the disposal of library patrons throughout the nation.

Of course, NTIS and GPO cannot possibly disburse all of the environmentally related information produced by the Federal Government and its contractors. Each agency or department within the government has its own means of disseminating the specialized information it produces. Many of these specialized services dealing with environmental and natural resources information are briefly described in the following discussion. Although many of these services are designed to respond to information requests from outside the Federal Government, others were set up specifically to respond to programmatic needs of their own agency or organization. However, access can usually be obtained either through the public information offices of the corresponding agency or through the intervention of another Federal agency. The information that follows is alphabetically organized by Federal agency as follows:

- Department of Agriculture
- Department of Commerce
- Department of Defense
- Department of Health and Human Services
- Department of the Interior
- Environmental Protection Agency
- Library of Congress
- National Science Foundation

In every case, both a complete mailing address as well as a telephone number have been provided.

DEPARTMENT OF AGRICULTURE

The Department of Agriculture (USDA) works to improve and maintain farm income and to develop and expand markets abroad for agricultural products. It conducts research in agriculture and biology; helps to curb and to cure poverty, hunger, and malnutrition; works to enhance the environment and to maintain our production capacity by helping landowners protect the soil, water, forests, and other natural resources; and safeguards and assures standards of quality in the daily food supply through inspection and grading services.

Agricultural Research Service
Beltsville, Md. 20705
(301) 344-2264

The Service carries out a basic, applied, and developmental research program in animal and plant protection and production; the use and improvement of soil, water, and air; the processing, storage, and distribution of farm products; and human nutrition at 147 locations nationwide and in 8 foreign countries. Experts are available to respond to questions, and research results are widely published.

Agricultural Research Service Ecogeographic File
Agricultural Research Service
14th St. and Independence Ave., SW
Washington, D.C. 20250
(301) 344-4419

This system depicts various areas in the world where crops are grown. The content is international in scope. The file is updated monthly if not weekly. Data include family; genus; species; location in country; longitude; latitude; pH of soil; annual rainfall; number of rain days per year; relative humidity; minimum, maximum, and mean temperatures; frost days per year; amount of sunshine; life zone; number of years; soil type; growing season; highest yield; lowest yield; nitrogen, phosphorus, and potassium fertilizers used; pesticides used; herbicides used; number of cultivations; seed-improvement type; tons of manure used; intercropping; fungicides used; and weedings. Answers to specific questions are reported by correspondence.

National Pesticide Information Retrieval System
Cooperative State Research Service
Agricultural Research Service
14th St. and Independence Ave., SW
(202) 447-7879

Compiles information on federally registered pesticides as well as those recorded through state product registrations. Publicly available on-line.

Economic Research Service
500 12th St., SW
Washington, D.C. 20250
(202) 447-7255

The principal function of the Economic Research Service is to provide timely and reliable agricultural economic information (research, forecasts of major agricultural economic indicators, policy analysis, and data) that addresses the economic concerns and the decision-making needs of farmers, consumers, workers in the private sector, and policy officials in the governmental sector. Economic analysis and research are conducted to identify and measure the relationships among economic variables. This research forms the basis of economic-activity monitoring, short-term forecasts, and long-range projections of resource needs, production, distribution, and the U. S. and world demand for food and other agricultural products. Economic analysis and research include measuring returns to producers and how well the agricultural and food sector meets the needs of domestic and foreign consumers. Economic information is also collected on the structural aspects of the agriculture and food sector of the national economy, the use of soil and water resources, the environment, and the impact of alternative private and public actions on rural communities and natural resources. The information is made widely available to farmers, farm organizations, farm suppliers, marketers, processors, consumers, and others who make production, marketing, or purchasing decisions and to legislators and other public officials through the Agricultural and Rural Economic and Social Information Service. The Economic Research Service's American Agricultural Economics Documentation Center also collects material dealing with agricultural economics. The material is intended for research and is available for use at the center in Washington, D.C.

Natural Resource Inventory
Soil Conservation Service
P.O. Box 2890
Washington, D.C. 20013
(301) 447-4530

This information system contains data on land use; soil, water, and wind erosion; land cover; conservation practices; and treatment needs for sample sites on private lands across the nation. Information is summarized with text, graphs, and maps describing the various combinations of land resources and influences on those resources. Tables of data are published as a USDA publication, and tapes of data files are available from the director of the Resources Inventory Division of the Soil Conservation Service.

Current Research Information System (CRIS)
National Agricultural Library
USDA Cooperative State Research Service
Beltsville, Md. 20705
(301) 344-3846

This system indexes and describes agricultural research projects that are currently in progress. Begun in 1967, it serves as the USDA-state research project system to improve communication among agricultural scientists, especially in regard to ongoing research, and to provide agricultural research planners with up-to-date coordinated planning information on the programs of the USDA and the state agricultural experiment stations. Each record includes items such as project number, performing organization, responsible organization, investigators and co-investigators, location, title, classification, and various fund and staff-support data. The text records include such items as objective, approach, keywords, progress, and publications. The system has nationwide coverage and is updated at least twice a month. Available commercially.

National Agricultural Library
U.S. Department of Agriculture
10301 Baltimore Blvd.
Beltsville, Md. 20705
(301) 344-3813

The National Agricultural Library (NAL) is one of the three national libraries of the United States. Its collection covers information from around the world on all aspects of agriculture. Supports library users and library systems around the country and world with a variety of library services (reference, interlibrary loan of agricultural publications not found elsewhere, etc.). A major service it offers is a computerized bibliographic control system for the international agricultural literature. This system is made up of four initially separate data bases, provides an index to the monograph and serial literature contained in the Library, and is available commercially. Data are derived from cataloging-indexing records pertaining to the books and journal articles acquired by the Library. It also publishes bibliographies, a listing of serials currently received, a listing of serial reports, its library catalog, and the hard-copy *Bibliography of Agriculture*.

Snow Surveys and Water Supply Forecasting
P.O. Box 2890
Washington, D.C. 20013
(202) 447-2241

This system gathers and validates snow and other hydrometeorological data and uses those data for forecasting available water at downstream points for agriculture water management, irrigation, flood control, and the like. Water-supply forecasts are announced monthly.

Statistical Reporting Service
14th St. and Independence Ave., SW
Washington, D.C. 20250
(202) 447-2130

The service provides statistical and economic data on food and agriculture essential to farmers, processors, and handlers in making production and marketing decisions and to legislators and other public officials. The data are obtained through sample surveys of farmers and agribusinesses. National and state agricultural statistics are collected and published on such subjects as field crops; fruit and vegetables; cattle; hogs; poultry; prices received by farmers; prices paid by farmers for goods, services, and taxes; farm employment; and farm wage rates. Forecasts on approximately 120 crops and 45 types of livestock are included in more than 300 national reports and 5000 official reports issued each year.

Soil Survey Interpretations
Soil Conservation Service
P.O. Box 2890
Washington, D.C. 20013
(202) 447-8872

The service provides land-use planners and managers with information about the suitability of various soil types for specific uses. Interpretive records about different series of soils are compiled in which the soils are classified, soil properties are estimated, soil limitations and suitability are listed for various applications, soil suitability for forestation and wildlife support are estimated, and predicted yields for selected crops are given. The system contains more than 12,000 records and is updated monthly. The system produces soil survey reports and tabular publications.

Western Forestry Information Network Pacific
Southwest Forest and Range Experiment Station
1960 Addison St.
Box 245
Berkeley, Calif. 94701
(415) 486-3114

WESTFORNET is a special-library network serving cooperating institutions in 15 western states. The network provides general document delivery reference and referral services, computer-based literature searches, and current-awareness publications to users in remote areas. It is designed to assist land-management decisions and forestry-technology transfer.

Water Pollution Abatement Project Inventory
USDA Forest Service
P.O. Box 2417
Washington, D.C. 20013
(703) 235-8043

This system provides a service-wide inventory record for all water pollution abatement projects administered by the U. S. Forest Service. Each record includes project schedule, cost estimate, and status for each project. Data coverage includes 79 project characteristics. The system contains more than 300 records. Information is updated and published semi-annually.

Potable Water Supply Inventory
USDA Forest Service
P.O. Box 2417
Washington, D.C. 20013
(703) 235-1475

A service-wide inventory of all potable water systems and swim-water sites administered by the U. S. Forest Service. Includes 69 project characteristics; contains more than 5000 records. Information is updated and published annually.

DEPARTMENT OF COMMERCE

The Department of Commerce encourages, services, and promotes the nation's international trade, economic growth, and technological advancement through a wide variety of programs. Among other missions, it offers assistance and information to increase exports; provides social and economic statistics and analyses for business and government planners; provides research and support for the increased use of scientific, engineering, and technological knowledge; grants patents and registers trademarks; provides assistance to promote domestic economic development; and seeks to improve understanding of the earth's physical environment and oceanic life.

National Oceanographic Data Center
NOAA
2001 Wisconsin Ave., NW
Washington, D.C. 20235
(202) 634-7500

Data are collected by the Center from other components of NOAA, private industry, private organizations, universities, individuals, international organizations and expeditions, and institutions cooperating with the United Nations. The information covers all oceans, seas, and estuaries; data are updated continually. The collected information constitutes the world's largest usable collection of oceanographic data, and the Center supplies the information to the public through responses to telephone and written queries, publications, and the dissemination of computerized data.

NOAA Office of Oceanography and Marine Services
National Ocean Survey
6001 Executive Blvd.
Rockville, Md. 20852
(301) 443-8487

The Office publishes oceanographic and related meteorological information in the form of observations, analyses, assessments, and predictions required for safe, rational, effective, and economic use of oceans, coastal zones, and the Great Lakes. Such information describes the natural environment, tides, currents, and lake levels and the state and the trends of the environment caused by human activities. The information is provided by publications, data services, or real-time data transmissions to ocean users. The Office provides national leadership in conducting assessments and disseminating information on multiple ocean uses, such as waste disposal and energy development. It conducts studies on coastal regions; assesses impacts of ocean use; provides scientific support to assessments of damage from oil and hazardous materials; and sponsors research, development, testing, and evaluation programs.

World Data Center A, Meteorology Federal Bldg.
Ashville, N.C. 28801
(704) 258-2850

World Data Center A, Oceanography
Page Bldg. 1, Rm 414
NOAA
Washington, D.C. 20235
(202) 634-7249

The center is one of the World Meteorological Organization's two major repositories; it collects and disseminates international data on meteorology and oceanography. Information from specialized, large-scale, or global experiments is available to researchers, industry, and the general public. The collection includes satellite data, storm data, river stages, temperature and precipitation data, solar radiation, ozone concentration, marine scientific observations, marine data inventory forms, and other measurements. The Center publishes a series of data summaries, records of weather events, statistics of extremes, and catalogs of data and publications.

Resource Statistics Division of the National Marine Fisheries Service
3300 Whitehaven St., NW
Washington, D.C. 20235
(202) 634-7366

This organization maintains and provides information to the public and to government agencies for research and for management, business, and environmental decision making. Data are collected through surveys, converted to machine-readable form, verified, edited, tabulated, published, and archived. Data on recreational and commercial marine fisheries include quality, value, method, and source of catch; number of fishermen; number, characteristics, gear, and crew data on fishing operations, import, export and processing of fisheries products; and current market information. Data are output weekly, monthly, and annually; publications include Fisheries of the United States, Fisheries Statistics of the United States, monthly landings bulletins, and the Frozen Fish Report.

Bibliographic and Information Services (NTIS)
5285 Port Royal Rd.
Springfield, Va. 22161
(703) 487-4600

NTIS compiles and publishes bibliographic data about U. S. Government publications about scientific and technical research and development. It collects, reproduces, and disseminates those publications; compiles and publishes bibliographies; and acts as a broker for government-produced computerized data.

Department of Commerce
Washington, D.C. 20233
(301) 449-1600

The Division serves as the focal point for receiving users' requests for summary tapes, computer program packages, selected maps, and related products from the Bureau of the Census. It maintains more than 2500 data files of tabulated or summarized data from the decennial and economic censuses. Special tabulations of census data can be prepared on magnetic tape, on microfilm, and as computer printout. The computer programs provide for accessing, matching, manipulating, and displaying census data and geographic information.

Tides Data Base
NOAA
6001 Executive Blvd.
Physical Oceanography Div.
Rockville, Md. 20852
(3001) 443-8938

This service facilitates user access to data necessary for computing tidal constants, tidal datums, and tide tables. The system supports the annual publication of the Tide Tables and contains basic data on tides, hourly tide heights, and tide statistics. Specialized tide tables, magnetic tapes of tide data, and miscellaneous publications are also issued. Tide records cover 1965 to the present, but records from some stations date from 1854.

Report of Observations/Samples Collected by Oceanographic Programs
NOAA
2001 Wisconsin Ave., NW
Page Bldg. 1
Washington, D.C. 20235
(202) 634-7298

This data base includes information on researching institutions, types of studies, parameters measured, project cycles, chief scientists, geographic areas, cruise numbers, ship/platform data, disposition of data, and whom to query for further information. This system contains basic research data on biology, geology, meteorology, oceanography, and pollution. Reports of findings are published.

Census Bureau Population Statistics System
Bureau of the Census
Department of Commerce
Washington, D.C. 20230
(301) 763-7646

A census of population has been taken every ten years since 1970. Census information includes a wide variety of statistical data about the people and economy of the nation. Output includes printed reports, computer tapes, and special tabulations. Catalogs, guides, and directories, which are useful in locating information on specific subjects, are also produced.

International Demographic Data Center
Rm. 302
Scuderi Bldg.
6101 28th Ave.
Marlow Heights, Md. 20748
(301) 763-2870

This service is an international data base of demographic, social, and economic data by urban and rural areas. Data on approximately 75 variables are compiled, analyzed, and adjusted where applicable. Contains data for all countries of the world covering 1950 to the present and is projected, in some cases, to 2010.

Data Inventory Dictionary and Tracking System
National Oceanographic Data Center
NOAA
2001 Wisconsin Ave., NW
Washington, D.C. 20235
(202) 634-7500

The National Oceanographic Data Center has developed a dictionary and tracking system to manage and control information about environmental data. The inventory provides information on the type and source of the environmental data, dates of coverage, medium on which the data are available, and the amount of data. The system is divided into four disciplinary data bases: ocean station data, bathythermograph data, other physical oceanographic data, and multidisciplinary data. The Center responds to telephone and written inquiries from the general public.

NODC Data Inventory Data Base
National Oceanographic Data Center
NOAA
2001 Wisconsin Ave., NW
Washington, D.C. 20235
(202) 634-7394

The system provides an interactive inventory of all data holdings of the National Oceanographic Data Center. It responds to queries by telephone or correspondence from the general public.

National Environmental Data Referral Service (NEDRES)
Assessment and Information Services Center
NOAA/NESDIS(E/IA)
Page Bldg. 2, Rm. 290
3300 Whitehaven St., NW
Washington, D.C. 20235
(202) 634-7722

This service enables any user of environmental data to determine whether specific environmental data exist and, if so, where they might be obtained. Entries describe available data, give the name and telephone number of the contact for the data, and list the conditions of availability. Data are available on-line and as computer outputs and in microform. Contained 14,000 records in 1984; it is continually updated. A hard-copy version of the data base is also available as the North American Climatic Data Catalog, Part I (published in January of 1984).

Assessment of Information Services Center
NOAA/NESDIS(E/IA)
Page Bldg. 2, Rm. 290
3300 Whitehaven St., NW
Washington, D.C. 20235
(202) 634-7251

The Center maintains a collection of NOAA publications, provides reference services for specialized questions, and maintains and operates the National Environmental Data Referral Service data base. The Center develops models to simulate the environment of environmentally sensitive study areas. These models quantify climate-associated fluctuations and the socioeconomic consequences of those fluctuations. The results serve as the basis for long-range, large-scale program planning. Such applications as crop-weather interrelationships have been modelled. Much of the input data comes from NOAA historical records and Bureau of the Census files.

Fishery Statistics Data Base Assessment and Information Services Center
NOAA/NESDIS(E/IA)
Page Bldg. 2
3300 Whitehaven St., NW
Washington, D.C. 20235
(202) 634-7366

This data base provides federal, state, and university researchers and industry management with information necessary to assess the economic and environmental impact of the fishing industry and to support future policy formulation. Publishes its data in report form.

Coastal Zone Information Center
3300 Whitehaven St., NW
Washington, D.C. 20235
(202) 634-4255

The Center maintains biological, environmental, legal, political, geographic, planning-managerial, and statistical information about coastal areas. It provides information about coastal zone management issues to the public and to government agencies for research, management, and decision making.

National Climatic Data Center
NOAA, NESDIS
Federal Bldg.
Asheville, N.C. 28801

The Center acquires, processes, archives, analyzes, and disseminates global climatological data and develops analytical and descriptive products to meet user requirements. It is the collection center and custodian of all U. S. weather records and the largest climatic center in the world.

National Marine Pollution Information System
National Oceanographic Data Center
NOAA
Page Bldg. 1
2001 Wisconsin Ave., NW
Washington, D.C. 20235
(202) 634-7500

The system is an automated catalog of federal ocean pollution research, development, and monitoring programs. The data base contains fiscal and programmatic information on the programs of eleven federal agencies. The Center responds to telephone and written inquiries from the general public.

DEPARTMENT OF DEFENSE

The Department of Defense is responsible for providing the military forces needed to deter war and protect the security of the country. The Department has a large effect on the environment because of the size of its physical plant, its construction projects, the work force it maintains, and its requirements for strategic materials.

Defense Pest Management Information Analysis Center
AFPMC/DPMAIC
Forest Glen Section
Bldg. 187
Walter Reed Army Medical Center
Washington, D.C. 20307
(301) 427-5365

The Center collects, indexes, stores, and disseminates published and unpublished technical literature primarily on arthropod pest biology and integrated control and management. Other topics include rodent and bird control; weed management; pesticide usage, training, and safe disposal; and various other noxious plant and animal problems of concern to the Department of Defense. The Center publishes bibliographies that are distributed through NTIS and a monthly Technical Information Bulletin that reviews the relevant literature. Its information-retrieval services are available to federal agencies, federal contractors, and state and local governments.

Soil Mechanics Information Analysis Center
U.S. Army Engineer Waterways Experiment Station
Attn: WESGC
P.O. Box 631
Vicksburg, Miss. 39180
(601) 636-3111

This Center collects, analyzes, and distributes information on soil mechanics. It conducts literature searches, prepares state-of-the-art reviews and bibliographies, and makes referrals to organizations or individuals with specialized expertise.

Hydraulic Engineering Information Analysis Center
U.S. Army Engineer Waterways Experiment Station
Attn: WESHI
P.O. Box 631
Vicksburg, Miss. 39180
(601) 636-3111

This Center collects, analyzes, and distributes information on hydraulic engineering. It conducts literature searches, prepares state-of-the-art reviews and bibliographies, and makes referrals to organizations or individuals with specialized expertise.

Defense Technical Information Center
Bldg. 5
Cameron Station
Alexandria, Va. 22314
(202) 274-7633

DTIC is the central repository for the Department of Defense's scientific and technical publications and information collections. All DOD researchers and contractors are required to deposit all publications developed under DOD funding at DTIC. Defense contractors and many "potential" contractors can gain access to the Center's collections. Some of the Center's services are also available to the general public through the National Technical Information Service. The principal DTIC data banks are the Research and Technology Work Unit Information System (research in progress), the Technical Report Program (which abstracts and indexes the defense report literature), and the Independent Research and Development Data Bank.

Sensitive Wildlife Information System
WESD
U.S. Army Corps of Engineers
Engineer Waterways Experiment Station
P.O. Box 631
Vicksburg, Miss. 39180
(601) 634-3111

Provides authoritative information on selected plants and animals in a narrative format on habits and habitat requirements of selected species. Information includes: the degree of protection and welfare benefits accorded the species under federal and state or territorial law; its geographic distribution including a distribution map that is plotted automatically when requested by the user; the known behavioral characteristics and habitat requirements that relate particularly to its adaptability to structural changes in its environment; its population structure and trends; and a list of information source documents. It covers all rare and endangered mammals and some birds and fish. It was last updated in 1976. The computerized information system is maintained off-line but is made accessible to authorized users upon request.

Hydrologic Engineering Center
609 Second
Davis, Calif. 95616
(916) 440-3285

This Center conducts research in hydrologic engineering. It has developed computer programs and models for flood hydrographic, water-surface profiles, reservoir system analysis, streamflow simulation, rating and flood routing, basin rainfall and snowmelt computation, urban storm water runoff, and other applications. It also produces a variety of reports and forecasts on hydrologic engineering.

Defense Mapping Agency
Hydrographic/Topographic Center
Washington, D.C. 20315
(202) 227-2060

The DMAHTC maintains a comprehensive collection of maps, city plans, and related graphics and documents; a worldwide coverage of horizontal and vertical controls of all orders; a file of standardized foreign place names; and a repository for echo-sounding bathymetric data in coastal and ocean areas; and a composite collection of U. S. and foreign produced nautical charts. The Center also operates and maintains the Worldwide Notice to Mariners System providing current information on hydrographic chart corrections and daily broadcast warnings of marine navigation hazards.

Environmental Technical Information System (ETIS)
U.S. Army Engineer Construction
Engineering Research Division
Environmental Division
Box 4005
Champaign, Ill. 61820
(217) 352-6511

The system has three subsystems. They enable planners to determine how an Army activity affects various aspects of the environment, help predict if an activity will have a significant impact on a local economy, and present an up-to-date collection of federal and state environmental regulations and standards written in easy-to-understand narrative text.

DEPARTMENT OF HEALTH AND HUMAN SERVICES

The Department of Health and Human Services is charged with the maintenance and improvement of the health of the nation, the caliber of health care, and the quality of the food supplied to the nation's citizens among other missions. To fulfill these charges, it conducts both scientific and social research in a wide variety of subject areas, compiles statistics, and disseminates information about food, drugs, medical techniques, health statistics, the aging process, and the social needs of the population.

Medical Literature Analysis and Retrieval System (MEDLARS II)
U.S. National Library of Medicine National Institutes of Health
U.S. Department of Health and Human Services
8600 Rockville Pike
Bethesda, Md. 20209
(301) 496-1351

This program collects and disseminates bibliographic and monographic information important to the progress of medicine and health. MEDLARS is an information storage and on-line retrieval system that currently serves on-line, international, biomedical, institutional users through more than 700 communication nodes. The subject matter is designed to help health professionals find out easily and quickly what has been published on any specific biomedical subject. Covers the worldwide literature from 1966 to the present. Most of the 13 on-line data bases that make up the system are updated monthly. Access is obtained through regional medical libraries.

National Library of Medicine
National Institutes of Health
U.S. Department of Health and Human Services
8600 Rockville Pike
Bethesda, Md. 20209
(301) 496-6308

The NLM aids the dissemination and exchange of scientific information important to the progress of medicine and health. The Library acquires and preserves books, periodicals, prints, and audiovisuals; catalogs and indexes the materials; publishes catalogs, indexes and bibliographies; lends materials through regional medical libraries; provides reference and research assistance; provides grant assistance to medical libraries; and engages in research and development activities related to biomedical communications. The collection consists of more than 2 million items. A separate collection of publications issued before 1871 is maintained.

Clearinghouse for Occupational Safety and Health Information
4676 Columbia Pkwy.
Cincinnati, Ohio 45226(513) 684-8326

The Clearinghouse collects, organizes, and retrieves published and unpublished technical information related to the field of occupational safety and health. This includes adverse effects of chemical substances, physical agents, psychological stress, sampling and analysis techniques, engineering controls, personal protective equipment, and recommended standards. It also maintains and operates NIOSHTIC, a computer-based bibliographic retrieval system for occupational health and safety research. The Clearinghouse responds to telephone or written requests for information. No charges are made for the service.

Vital Statistics Data Systems
3700 East West Hwy.
Rm. 144
Hyattsville, Md. 20782
(301) 436-8951

This system provides statistics of wide public interest of live births, deaths, fetal deaths, abortions, marriages, and divorces or dissolutions of marriages. Vital statistics include a range of demographic and medical data related to these events. Provisional statistics are published monthly and annually. Results appear in *Vital Statistics of the United States*; the *Monthly Vital Statistics Report* and supplements; the *Vital and Health Statistics* series; and public-use data tapes.

Health and Nutrition Examination Survey Statistics
3700 East West Hwy.
Rm. 258
Hyattsville, Md. 20782
(301) 436-7068

This program is the sole source of national morbidity data obtained through direct examination and clinical tests of samples of the population to measure health status and to collect data on undiagnosed and untreated diseases. The system produces continual reports in hard copy.

Toxicology Information Response Center
Oak Ridge National Laboratory
P.O. Box X
Oak Ridge, Tenn. 37831
(615) 576-1743

The Center is sponsored by the National Library of Medicine. It is concerned with the toxicological effects of chemicals that occur in foods and the environment. It conducts individualized literature searches, offers selective dissemination of information, compiles and publishes bibliographies, and prepares state-of-the-art reviews.

DEPARTMENT OF THE INTERIOR

The Department of Interior is the nation's principal conservation agency. It has responsibility for most of the publicly held lands and natural resources. It fosters the wisest use of land and water resources, protects fish and wildlife, preserves the environmental and cultural values of the national parks and historical places, assesses the nation's mineral resources, and provides for the enjoyment of life through outdoor recreation.

National Water Data Exchange
USGS
National Center, Stop 421
12201 Sunrise Valley Dr.
Reston, Va. 22092
(703) 860-6031

NAWDEX is a national confederation of water-oriented organizations working together to improve users' identification, location, and acquisition of water data. It maintains a computerized data base that identifies more than 300 water-oriented organizations in the public (federal, state, and local) and private sectors and the water data they hold. Included in the data base are the type of data held by the organization, geographic area covered, and location of data for more than a half-million sites. NAWDEX services are available to everyone through a nationwide network of more than 60 assistance centers. These centers can provide the user with access to a variety of other information services, such as the USGS's National Water Data Storage and Retrieval System, the EPA's Storage and Retrieval System, NOAA's Environmental Data and Information Service, the Water Resources Scientific Information Center's bibliographic data service, various state water and natural resources information systems, and Canada's Water Resources Document Reference Center. Charges are associated with some of the services offered by the NAWDEX assistance centers.

Multi-State Fish and Wildlife Information Systems
Eastern States Office
350 South Pickett
Alexandria, Va. 22304
(703) 235-9643

On a state-by-state basis, this system collects, stores, and retrieves information about the taxonomy, status, food habits, management practices, and other related attributes of indigenous animal species.

Geologic Inquiries Group
USGS
907 National Center
12201 Sunrise Valley Dr.
Reston, Va. 22092
(703) 860-6517

This office answers written and telephone questions on topics, such as earthquakes, energy, the geology of specific areas, and geologic maps and mapping. Information on geologic map indexes is also available. Questions that cannot be answered are referred to the appropriate information source with the agency.

Water Resources Scientific Information Center
19th and C Streets, NW
Washington, D.C. 20240
(202) 343-8435

This service disseminates scientific and technical information to the water resources community through a monthly abstract bulletin, a computerized file of ongoing projects, topical bibliographies, and computer searches. Information dealing with water-related aspects of the life, physical, and social sciences, as well as related engineering and legal aspects of the characteristics, conservation, control use, or management of water is amassed for 1968 to the present. Updated monthly; coverage is world-wide. Some services limited to in-house users.

National Cartographic and Geographic Information and Data Services
507 National Center
12201 Sunrise Valley Dr.
Reston, Va. 22092
(703) 860-6031

The Center maintains a data system that contains information on the availability of aerial and space images, maps, charts, geodetic data, and related digital data produced by the USGS, other federal agencies, selected states and local agencies, and some private sources. The Center makes available such products as index maps and catalogs, showing the status of published maps, mapping data, and aerial photography in the United States; non-technical brochures describing various cartographic data; names and addresses of the agencies and private organizations that hold cartographic data; descriptive lists of geographic features of selected maps published by the USGS and other agencies; and a newsletter describing recent activities.

National Mapping Program
USGS
519 National Center
12201 Sunrise Valley Dr.
Reston, Va. 22092
(703) 860-6301

This service coordinates the national cartographic surveying activities. It collects information in a family of general-purpose maps and related cartographic products and digital data covering the United States and the outlying areas providing land reference systems; hypsography; hydrology; boundaries; transportation systems; cultural features, such as buildings, airports, dams, etc.; geodetic control and survey monumentation; geographic names; orthophotographic imagery; and land use and land cover data. It publishes standard topographic maps in quadrangle or digital cartographic data, intermediate-scale base maps, land-use and land-cover maps and related statistical data, orthophotoquads, and various small-scale and special map products.

Branch of Distribution
USGS
1200 South Eads St.
Arlington, Va. 22202
(703) 557-2781

The Branch publishes New Publications of the Geological Survey monthly. It is available free upon request. The Branch also disseminates maps, charts, circulars, bulletins, professional papers, and other publications of the USGS.

USGS Water Information Group
420 National Center
12201 Sunrise Valley Dr.
Reston, Va. 22092

Provides information on water resources in general and about the water resources of specific areas of the United States to the general public.

ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency's mission is to control and abate pollution in the areas of air, water, solid waste, noise, radiation, and toxic substances. It attacks these problems in coordination with state and local governments.

EPA Pesticides and Toxic Substances Technical Information Center
USEPA
Waterside Mall
Rm. E447
401 M St., SW
Washington, D.C. 20460
(202) 382-3529

The Center is a centralized resource for chemical, health, and ecological information on industrial and commercial chemical substances. It is made accessible to the private and academic sectors as well as to individuals concerned with environmental issues. It provides reference services in response to inquiries about chemical or related environmental aspects, conducts TSCA Inventory searches of the public file, makes interlibrary loans to other libraries, and publishes bibliographies.

EPA Public Inquiry Center
West Tower, Gallery 1
Waterside Mall
401 M St., SW
Washington, D.C. 20460
(202) 382-7550

The Center provides informational and educational materials and assistance to private citizens, governments, industry, academia, and public and private organizations. It responds to written, telephone, and walk-in inquiries with publications, reports, and fact sheets.

Chemical Substances Information Network
722 Jackson Pl., NW
Washington, D.C. 20006
(202) 382-2256

A central computer facility for accessing data bases distributed around the world and containing bibliographic and numerical data about the environment and natural resources. It automatically accesses these data bases and allows the user to address them by means of a standardized command language and thesaurus. Currently in the developmental stage.

LIBRARY OF CONGRESS

The Library of Congress is the center of the nation's attempt to provide bibliographic control of printed publications and the major center of information flow through American society about all subject matters. It provides special facilities for research and access to its collection. The staff responds to reference and bibliographic inquiries and serves Congress, government agencies, and the general public who have exhausted other information sources. It provides these referral and bibliographic services in person, by telephone (287-5522), through correspondence, and through published bibliographies. Its interlibrary loan service (287-5444) is intended to supplement the resources of local, state, and regional libraries.

National Referral Center
Library of Congress
10 First St., SW
Washington, D.C. 20540
(202) 287-5670

This Center is a free referral service that directs those that have questions about any subject to organizations that are qualified and willing to provide answers. The service uses a subject-indexedcomputerized listing of more than 12,000 organizations. Each entry provides the special fields of interest of an organization and the types of information service it is willing to provide along with its address, telephone number, and associated data. The data base is a component of the Library's Information System. Besides accessing it through the Center's staff, a health and environment subset of the file can be accessed on the DIRLINE file of MEDLINE. Subject-specific subsets of the data base are occasionally prepared by the Center's staff and issued as Library of Congress publications.

Library of Congress Information System
Library of Congress
10 First St., SW
Washington, D.C. 20540
(202) 287-5563

A number of files make up this system. Accessibility to them varies from file to file. The system includes information on legislative action on bills; abstracts of pages of the *Congressional Record*; briefs on public policy issues; bibliographic citations to publications that cite books, maps, and serials; and information on organizational sources about scientific, technical, and social-science topics.

NATIONAL SCIENCE FOUNDATION

The National Science Foundation promotes the progress of science and engineering through the support of research and education programs. Its educational programs are aimed at ensuring increasing understanding of science at all educational levels and an adequate supply of scientists and engineers for the nation's needs.

Information Resources, NSF
Communication Program
Rm. 419
1800 G St., NW
Washington, D.C. 20550
(202) 357-7484

This Program collects, organizes, preserves, and disseminates the reports and other documentation that result from research projects supported by the NSF covering engineering, the environment, resources, productivity, technology assessment and utilization, and energy.

SECTION 2

PUBLISHED RESOURCES

In this section are listed sources of information, compiled in print or in computer files, that will lead the reader to U. S. Government-produced data and information about the environment or natural resources. To facilitate their use, the sources have been grouped into categories as follows:

- Abstract and Index Journals and other Guides to the Literature
- Data Bases
- Recent Bibliographies and Reviews
- Handbooks, Manuals, and Catalogs
- Maps, Drawings, and other Graphic Information
- Directories

Entries for abstract and index journals give the name, dates of publication, and description. Entries for data bases give the name, the types of data or the dates of coverage for bibliographic files, descriptions, and availability; the indicators of availability are explained in another section of this document.

ABSTRACT AND INDEX JOURNALS

Science Citation Index, 1961-

In three main parts. (1) The Citation Index lists alphabetically the people (and their works) who have been cited in the world's scientific literature. The authors citing them and the articles in which they are cited are also given. (2) A subject index to the articles in which the citations are made (essentially a subject index to a large portion of the current scientific literature). (3) The Source Index, which lists all the citing articles alphabetically by first author (essentially an author index to a large portion of the current scientific literature).

Index to Scientific Reviews, 1974-

Provides bibliographic citations to review articles on science, medicine, agriculture, technology, and behavioral science that appear in publications around the world.

Current Contents, 1961-

Reproduces the tables of contents of pertinent research journals and books and indexes them by author and by subject. Distributed weekly in several discipline-oriented editions:

Life Sciences
Physical, Chemical and Earth Sciences
Agriculture, Biology and Environmental Sciences
Engineering, Technology, and Applied Sciences
Clinical Practice
Arts and Humanities
Social and Behavioral Sciences

E. Herman, Locating United States Government Information, A Guide to Sources, William S. Hein, Buffalo, N.Y., 1983

A "how-to" guide in a workbook format; pedagogic in nature. Describes government documents in general, the Government Printing Office, and numbering schemes for identifying government documents. Tells how to trace a bill through Congress, use the CIS/Index, find Congressional publications, use indexes and guides to legislation and regulations, locate federal statistics, use census information, locate technical reports, find maps and audiovisual materials, and use the Freedom of Information and Privacy acts. Contains an annotated bibliography. Indexed by title.

Chemical Abstracts, 1907-

The most comprehensive abstract journal of and index to the world's chemical literature, covering books, patents, journal articles, conference proceedings, and report series. Organized by subject. Half of the subject sections are issued each week. Indexed by author, subject, chemical name, chemical formula, ring formation, patent number, and CAS Registry Number. Covers all aspects of chemistry with due attention paid environmental chemistry, agricultural chemistry, and biochemistry. A variety of spinoff services also available, such as published subject subsets of the CAS data base, called CA Selects, issued biweekly for more than 140 topics.

Chemical Titles, 1960-

A listing of the tables of contents of chemical journals from around the world. Titles are permuted to provide subject access. Indexed by author.

Current Abstracts of Chemistry and Index Chemicus, 1960-

Provides an index to and extracts from the scientific journal literature announcing the identification of new chemical substances, reactions, syntheses, or isolations. Indexed by author, by subject, by corporate author, by molecular formula, and by source.

Pollution Abstracts, 1970-

Abstracts and indexes the world's literature on air pollution, water pollution, solid waste, noise, pesticides, and general environmental quality.

NTIS and Office of Federal Statistical Policy and Standards, Directory of Federal Statistical Data Files, U.S. Department of Commerce, Washington, D.C., 1981

A catalog and bibliography of machine-readable data files released by the Federal Government. Organized by federal agency. Each entry gives name of file, preparing agency, a reference number, a general description, the geographic coverage, the time coverage, the technical characteristics, available reference materials and related documents, the names of related files, personal contacts, and the availability of the given file. Indexed by file titles, by agency, by subject matter, and by subject matter by agency. Contains a glossary.

Environmental Periodicals Bibliography, 1972-

Gives bibliographic citations to the world's environmental journal literature (arranged by subject matter), and provides author and subject indexes to those bibliographic citations. Covers human ecology, air, energy, land resources, agriculture, marine and freshwater resources, water pollution, land resources, nutrition, and health. Appears bimonthly.

EPA Publications Bibliography: Quarterly Abstracts Bulletin, 1977-

Published by the U. S. Environmental Protection Agency, this journal abstracts and indexes the publications of that agency and its contractors. The entries are ordered alphanumerically by NTIS order/report number. The entries are indexed by title, keyword, sponsoring EPA office, corporate author, personal author, and contract/grant number. Issued quarterly; indexes are cumulated annually; issues have individual report numbers. This work constitutes a continuing updating of the EPA *Cumulative Bibliography*, 1970-1976. The *Quarterly Abstracts Bulletin* is available from NTIS on a subscription basis.

NTIS Weekly Abstract Newsletter: Agriculture and Food

An excerpt from the NTIS Bibliographic Data Base that lists all of the records related to this subject entered into the Data Base during the week. Provides a bibliographic citation and an abstract for each entry.

Abstracts on Health Effects of Environmental Pollutants, 1972-

A published subset of the BIOSIS (*Biological Abstracts*) and MEDLARS data bases. Covers occupational health, industrial medicine, the effects on human health of chemical substances in the environment, animal studies of toxic substances, food-chain vectors, and related analytical techniques.

AgrIndex, 1975-

Indexes the world's book, journal article, atlas, report and other literature on agriculturally related material. Most entries include abstracts.

Biological and Agricultural Index, 1916-

Provides a subject index to the contents of 150 journals dealing with biology and agriculture.

K. A. Hammond, G. Macinko, and W. B. Fairchild, *Source book on the Environment, A Guide to the Literature*, University of Chicago Press, Chicago, 1978

This work predominantly consists of annotated commentaries that review the basic literature in 24 areas of environmental science and that provide a bibliographic tutelage to the prospective reader of that literature or to a new researcher. These 24 areas are grouped in three main sections on environmental philosophies and perspectives, case studies on environmental alteration and control, and the major components of and influences on the environment (air water, land forms and soils, vegetation, animals, the coastal zone, humans, and energy). Appendices briefly describe (1) selected portions of the environmental literature, (2) environment legislation, and (3) governmental and nongovernmental organizations dealing with the environment. Indexes are provided for the subjects dealt with and authors referred to in the text.

Bibliography of Agriculture, 1942-

The original publication and now a published subset of the AGRICOLA data base of the National Library of Agriculture. It provides bibliographic citations and indexes to the world's agricultural literature. It covers journal articles, pamphlets, and government publications on all aspects of agriculture. Appears monthly; available on a subscription basis from the Oryx Press.

Habitat Preservation Abstracts, 1979-

Published by the U.S. Fish and Wildlife Service, this journal abstracts and indexes the publications of the Service dealing with such issues affecting wildlife resources and their habitats as coal mining, coal conversion, mineral development, power-plant operations, and water-resource analysis. Issued irregularly, it is available directly from the Fish and Wildlife Service.

EIS Digests of Environmental Impact Statements, 1977-

Abstracts and indexes environmental impact statement filed with the U. S. Government. Arranged by topic (e.g., energy, land use, parks, forests, and water); indexed by subject, by law, by site, by agency, by EIS number, and by agency number.

J. L. Androit, *Guide to U.S. Government Publications*, Documents Index, McLean, Va., 1983

An annotated guide to the important series and periodicals currently being published by U. S. Government agencies and to important reference publications issued within the various series along with a complete list of the SupDoc classification numbers issued since 1900. Volume 1 covers agencies in existence after January 1, 1975, and Volume 2 covers agencies abolished prior to that date. Arranged by SupDoc number. Indexed by agency and by title.

V. M. Palic, *Government Publications, A Guide to Bibliographic Tools*, 4th ed., Library of Congress, Washington, D.C., 1975

A guide to bibliographic aids in the field of official publications issued by the U. S. Government, foreign countries, and international government organizations. The ∼ 3000 entries are generally bibliographies of publications, but catalogs, lists, and other aids are also included. Current and retrospective sources are cited. Arranged by geographic area with U. S. federal, state, and local government publications listed separately. Foreign countries clustered by area. Within those classes, works are grouped by agency. A short history of each U. S. Government agency is included before the descriptions of its bibliographies, catalogs, checklists, price lists, indexes, accession lists, and other aids. Entries are briefly annotated. The index covers select personal and corporate authors; titles of works; names of geographic areas, countries, provinces, states, etc.; and names of organizations.

Pesticides Abstracts*, 1974- ; formerly *Health Aspects of Pesticides: Abstracts Bulletin, 1968-1973

Published by the U. S. Environmental Protection Agency, this journal abstracts the international literature on the health effects of pesticides. Organized by subject matter: general; monitoring and residues; epidemiology, prevention, and treatment; toxicology and pharmacology; and analysis. Indexed by author, corporate author, and subject. Appearing monthly, it is available on a subscription basis from the USGPO, its general SupDoc number is EP5.9.

J. L. Hall and M. J. Brown, *Online Bibliographic Databases*, 3rd ed., Aslib/Gale Research, London/Detroit, 1983

A brief description of the international database industry and its operation is given. The main part of this publication is a catalog of data bases, containing the supplier, subject coverage, printed version, typical on-line record contents, chronological coverage, total number of citations, update size and frequency, availability (names of vendors who provide access charges, and available documentation. A bibliography on on-line data bases is included. Indexed by data-base name and supplier.

M. E. Williams, L. Lannom, and C. G. Robins, *Computer-Readable Databases, A Directory and Data Source-book*, American Society for Information Science, Washington, D.C., 1982

This listing of data bases is international in scope and is arranged alphabetically. The entry for each data base includes its name, update frequency, chronological coverage, correspondence with printed sources, producer, distributor, physical generator, availability and charges for acquisition, subject coverage, number of items, anticipated growth, type of source material, language of source material, country of data base publication, subject analysis and indexing data, data elements present, data base services offered, and user aids available. The entries are indexed separately by subject, producer, processor, and name.

***Directory of Online Databases*, Cuadra Associates, Santa Monica, Calif., revised quarterly**

This work starts with an overview of the use of on-line services. It then describes each data base by giving its name, type of data base, subject coverage, producer, on-line supplier, conditions of use (available free to the public, restricted to a certain clientele, available on a fee basis, etc.), description of content, language of data base, geographic coverage, chronological coverage, and update frequency. The entries are indexed separately by subject, producer, on-line service, and telecommunications service. The work ends with a master index.

J. L. Androit, *A Guide to U. S. Government Statistics*, Documents Index, McLean, Va., 1973

An annotated guide to more than 1700 recurring U. S. Government publications that present statistical data and to more than 3200 statistical series embedded in larger work (e.g., Vital and Health Statistics). Arranged by agency of the government and within those classes by SupDoc number. The 1700 government publications are indexed by agency, by subject, and by title.

Capital Systems Group, *Federal Environmental Data: A Directory of Selected Sources*, National Science Foundation, Washington, D.C., 1977

This directory describes about 110 of the major environmental data bases maintained by U. S. Government agencies. Most, but not all, of these data bases are computer-based files. The directory also includes several systems, information sources. Most of the entries originate in the Department of Agriculture, Department of Commerce, Department of the Interior, Department of Energy, and Environmental Protection Agency. Information sources from a few other agencies are also included. Organized by agency. For each agency, the major environmental data holdings are described and individual information sources are "profiled," giving source name, source agency, objective, general description, size, update frequency, time reference, cost, turnaround time in responding to requests for information, information products, and contact (with name, address, and telephone number).

A. E. Fusonie, *Guide to Manuscripts in the National Agricultural Library*, USDA Misc. Publ. 1374, Science and Education Administration, Beltsville, Md., 1979

Lists and describes the account books, broadsides, diaries, business records, letters, personal papers, memoirs, photographs, records and other manuscripts held by the National Agricultural Library and other USDA libraries.

M. J. Meshenberg, *Environmental Planning, A Guide to Information Sources*, Gale Research, Detroit, 1976

A bibliography of reference material from the periodical literature, government documents, scientific journals, and teaching materials. Each entry is annotated. Entries are arranged by topic: the environment and environmental issues, environmental planning, environmental impact analysis, environmental plans, soil, geology, natural hazards, water in the planning process, climatology, vegetation, wildlife, population and urban growth, environmental design, historical preservation, environmental health, noise in the environment, environmental law, energy, and the "new" land-use planning. Entries are indexed by author, title, and subject.

***NTIS Weekly Abstract Newsletter:*
*Environmental Pollution and Control***

An excerpt from the NTIS Bibliographic Data Base that lists all of the records related to this subject entered into the Data Base during the week. Provides bibliographic citation and abstract for each entry.

Selected Water Resources Abstracts, 1968-

Abstracts and indexes the literature of monographs, journal articles, and reports on water-related aspects of the life, physical, and social sciences as well as related engineering and legal aspects of the characteristics, conservation, control, use, or management of water. Published by the Department of the Interior.

Sport Fishery Abstracts, 1955-

Published by the U.S. Fish and Wildlife Service, this journal abstracts and indexes the literature on the research and management of noncommercial fisheries. Appearing quarterly, it is available on a subscription basis from the USGPO; its general SupDoc number is I49.40/2.

Wildlife Review, 1935-

Published by the U. S. Fish and Wildlife Service, this publication abstracts and indexes the literature issued by the organization on a quarterly basis. Available on a subscription basis from the USGPO, its general SupDoc number is I49.17.

WRC Information, 1974-

A weekly journal abstracting the world's journal, report, conference proceedings, and other literature on water resources, quality, monitoring and analysis, treatment, and use. Also covers sewage, industrial effluents, and effects of pollutants. No printed indexes.

G. J. Giefer, *Sources of Information in Water Resources: An Annotated Guide to Printed Materials,* Water Resources Center Archives, University of California, Berkeley, Calif., 1976

A bibliography of more than 1100 titles concerning water resources and bibliographic aids to the use of the environmental literature. Emphasizes but is not limited to the U. S. literature. Arranged by topic: general works; nature of water; water cycle; water supply; augmentation and conservation; water quality, management, and protection; water resources planning; and engineering works. Within these classes works are arranged by type of publication. Annotations vary from brief to comprehensive. Indexed by title, author, and subject.

***WRD (Water Resources Division) Information Guide,* U.S. Geological Survey, Reston, Va., 1982**

Describes the Division, its mission, its programs, and its organization. Gives titles, addresses, telephone numbers, and office hours of major contacts within the Division.

Abstract and Index Journals

Aquatic Sciences and Fisheries Abstracts, 1969-

Appears in two sections: (1) Biological Science and Living Resources and (2) Ocean Technology, Policy, and Nonliving Resources. Abstracts and indexes the international journal literature on limnology, aquatic biology, ecology, physical and chemical oceanography, and pollution effects on fish.

Commonwealth Agricultural Bureaux Abstracts

This series of journals abstracts and indexes the world's agriculturally related literature. Most of the journals cover books, journal articles, reviews, reports, and meetings. Most are issued monthly, are indexed by author, and are arranged by subject. Several of the journals are published by institutions other than the Commonwealth Agricultural Bureaux but in cooperation with the Bureaux. The titles of the journals related to aquatic and marine environmental sciences and their dates of publication are:

Irrigation and Drainage Abstracts, 1975-Leisure, Recreation, and Tourism Abstracts, 1977-

DATA BASES

TSCA Initial Inventory, current data

Provides EPA identification, nomenclature, and structural information on the ~54,000 chemicals initially covered by the Toxic Substances Control Act. Corresponds to the published list of the same title. Update irregularly. Available from DIALOG and SDC/ORBIT.

TSCA Plant and Production, current data

Provides references to ~127,000 sources of plant and production information related to ~53,000 substances listed in the *TSCA Initial Inventory* and its *Supplement*. Data include manufacturer's name and address, volume produced at each site, manufacturing and importing data, the manufacturer's identification number, and the chemical's CAS Registry Number. Available from NIH/EPA Chemical Information System and SDC/ORBIT.

CA Search, 1967-

Indexes the world's journal articles, patents, reviews, technical reports, books, and conference proceedings, dissertations and monographs on all chemistry-related topics. Corresponds to the bibliographic citations and indexes of the printed source *Chemical Abstracts*. Updated biweekly. Contained about 6.5 million records as of 1984. Available from Pergamon-InfoLine, DIALOG, SDC/ORBIT, BRS, CISTI, Telesystemes-Questel, European Space Agency, Japan Information Center of Science and Technology, and Japan Information Processing Service.

CAS Online, 1965-

Abstracts and indexes the world's chemical literature. Corresponds to *Chemical Abstracts*. In addition to access through the standard CA indexes (author, subject, chemical formula, etc.), access can also be gained through graphic portrayal of chemical structure or partial chemical structure. Bibliographic citations, abstracts, synonyms, CAS name and registry number, structure diagram, molecular formula, and the ten most recent references to the given substance in CAS are retrievable. Available from CAS.

CASSI, current data

Indexes periodicals and series abstracted and indexed in *Chemical Abstracts* and has a union list of holdings by more than 400 libraries in the United States and 27 other countries. Available from SDC/ORBIT.

Conference Papers Index, 1973-

Indexes about 100,000 papers presented at about 800 scientific and technical meetings held worldwide each year. Covers all scientific and technical fields, including the life sciences, engineering, and the physical sciences. Corresponds to the printed publication *Conference Papers Index*. Updated monthly; contained about 1.3 million entries as of 1984. Available from DIALOG and European Space Agency.

Congressional Information Sources, Inventories, and Directories Data Base, current data

This data base is maintained by the General Accounting Office and used by congressional analysts to identify sources of fiscal, budgetary, and program-related information and to publish the Congressional Sourcebook Series. It has four files: Requirements for Reports to the Congress (RCC), Federal Information Systems (FIS), Information Sources and Resources (ISR), and Federal Evaluations (FE). The RRC file covers information transmitted to Congress as the result of an official congressional report (under law or by personal communication). The FIS file covers management information systems; planning and forecasting systems; bibliographic data systems; data base management systems; and models simulations and statistical systems maintained by an agency or organization of the Federal Government to fulfill its mission. The ISR file lists catalogs, bibliographies, serials, guidebooks, directories, manuals, dictionairies, thesauri, statistical tables, special libraries, clearinghouses, research centers, information networks, and information analysis centers produced or operated by federal agencies in support of their missions. The FE file contains information on evaluations (assessing program alternatives, managerial effectiveness, research, and results, appraising whether programs achieve their stated results, meet their expectations, or produce significant effects) of federal programs, activities, functions, services, projects, and processes.

CHEMSEARCH, current data

An index to the entries cited in the most recent six issues of Chemical Abstracts. As such it is a subset of the CA SEARCH file. Information provided for each substance listed includes CAS Registry Number, molecular formula, name(s), synonyms, and ring data. Available from DIALOG.

Range Management, 1980-

Abstracts and indexes the U. S. and Canadian journal literature on ranching, range and pasture management, and livestock management. Corresponds to the printed publication *U. S.-Canadian Range Management*. Available from SDC/ORBIT.

SERLINE, current data

A catalog to the serial holdings (including numbered congresses) of the National Library of Medicine. Some entries give information about the presence of the periodicals at other locations. Corresponds to the micropublication Health

Sciences Serials. Available from Australian MEDLINE, BLAISE-LINK (Ireland and U. K.), and National Library of Medicine.

SPHERE (Scientific Parameters for Health and the Environment, Retrieval and Estimation), 1971-

Contains data extracted from the open literature. Those data define (1) the health effects of ~650 toxicants that can be dermally absorbed by humans and (2) the toxic effects of more than 2500 chemicals on freshwater and saltwater organisms. Available from NIH/EPA Chemical Information System.

NTIS Biblographic Data Base, 1964-

Abstracts and indexes the technical reports that have been entered into the NTIS system and are available for purchase through NTIS. Indexed by title, author, subject term, corporate author, contract number, and report-series-code number. Corresponds to the printed *Government Reports Announcements and Index*. Available from BRS, CISTI, DATA-STAR, DIALOG, European Space Agency, INKA Karlsruhe, and SDC/ORBIT.

U.S. Census of Agriculture, current data

Gives data on crops and livestock from the most recent quinquennial Census of Agriculture conducted by the Bureau of the Census and reported by the U. S. Department of Agriculture. Available from On-Line Research.

U.S. Fertilizer Forecast, 1955-

Has more than 350 quarterly and yearly historical and forecast series on the production, consumption, stocks, prices, acreages, etc., for nitrogen, phosphate, and potash fertilizers. Derived largely from USDA data. Available from Chase Econometrics.

MEDLINE/MEDLARS, 1966-

Abstracts and indexes the international literature on all of biomedicine. Produced by the National Library of Medicine. Corresponds to the printed indexes: *Index Medicus, Index to Dental Literature*, and *International Nursing Index;* also contains additional supplemental information. Abstracts cover from 1975 to the present; the file (without abstracts) extends back to 1966. Available from BLAISE-LINK (Ireland and U.K.), BRS, DATASTAR, DIALOG, DIMDI, Medical Information Center (Stockholm), and the National Library of Medicine.

ISI/MULTISCI, 1979-

A subset of SCISEARCH consisting of the entries in the subject areas of chemistry, physics, earth sciences, agriculture, environmental sciences, engineering, and applied sciences. Indexes the international journal literature in this field. Available from DIMDI.

American Profile, numerical data

1970 and 1980 census data, current-year updates, 5-year projects of some statistics, and more than 160 statistical characteristics of the U. S. population. Data available at user-defined levels (counties, SMSAs, circles of specified radii around cities, etc.). Available from Control Data Corp. and Dun and Bradstreet Computer Services.

CENDATA, textual and numerical data

Contains selected statistical data, press releases, and product information from the Bureau of the Census. Specializes in time-sensitive information, such as housing, agricultural, and population census data. The data base is derived from reports and other printed material issued by the Bureau of the Census. Data over 1980 to the present, primarily; but some historical data are also included. Available from DIALOG.

Selected Water Resources Abstracts, 1968-

Abstracts and indexes the international literature on the water-related aspects of the life, natural, and social sciences. Corresponds to the printed publication of the same name. Compiled by the U. S. Department of the Interior. Available from DIALOG, QL Systems, and SDC/ORBIT.

CRIS, current data

USDA's Current Research Information System. Describes and indexes work in progress being funded by the USDA inhouse, at state agricultural experiment stations, state forestry schools, and other institutions. Reports on a wide range of topics including biological sciences, natural resource conservation, environmental protection, outdoor recreation, fish and wildlife, resource management, food and nutrition, consumer health and safety, and forestry. Updated monthly. Available from DIALOG and SDC/ORBIT.

Digests of Environmental Impact Statements, 1970-

Abstracts and indexes all environmental impact statements filed with the Federal Government since 1970. Updated monthly. Available from BRS.

ENVIROLINE, 1971-

Indexes and abstracts international literature on the engineering, scientific, political, and socioeconomic aspects of the environment. Covers journal literature, reports, trade publications, symposia, and other sources from 1975 to the present. Updated monthly. Corresponds to the printed publication Environmental Abstracts. Available from BRS, DIALOG, European Space Agency, and SDC/ORBIT.

Environmental Bibliography, 1973-

Indexes the worldwide journal literature dealing with the environment. Corresponds to the printed publication Environmental Periodicals Bibliography. Updated bimonthly. Available from DIALOG.

Environmental Fate Data Bases, current information

A series of data bases that provide an index to the type of environmental-fate data available for more than 3200 organic chemicals, chemical and physical data on 465 representative organic chemicals released to the environment; and bibliographic citations to the international primary literature that supports the data presented. Available from Syracuse Research Corp.

Environmental Health News, 1981-

Brief news items related to the actions and operations of the EPA, NIOSH, and OSHA. Also covers court decisions, guidelines issued and developments related to the TSCA and other environmental and occupational health topics. Available from Occupation Health Services.

UPGRADE (also called DATAGRAF), numerical data

A system of numerical data bases along with software to search, combine, and display data, which consist of Bureau of Census, USGS, and EPA data on population, mortality, water quality, hydrology, and air quality and pollution. Available from Boeing Computer Services Co.

Federal Research in Progress (Formerly SSIE), current data

Produced by NTIS, this data base indexes and describes research in the physical sciences, engineering, and the life sciences currently in progress under federal funding. Updated semiannually. Available from DIALOG.

SCISEARCH, 1974-

Indexes contents of some 3800 journals from around the world on a broad range of scientific and technical subjects including agriculture, earth sciences, environmental sciences, physics, chemistry, and life sciences. Corresponds to the printed *Science Citation Index*. Available from DIALOG and DIMDI.

Agricultural Research Review, 1982-

Full-text write-ups about current agricultural research in the United States and Canada, especially that conducted by the USDA and the State Agricultural Experiment Stations. Available from NewsNet.

Agriculture, numerical data

More than 6500 time series on annual, semiannual, quarterly, monthly, and weekly commodities' supply, demand, and prices at national and state levels for the United States. Includes USDA data on crop production, acres planted and harvested, livestock production, prices paid and received by farmers, farm income, imports, and exports. Available from DRI.

CENSAC, numerical data

Contains 1980 Census of Population and Housing data from which users can retrieve information by state, county, minor civil division, place, and census tract. Corresponds to U. S. Census Bureau Summary Tape Files 1 and 3. Available from STSC.

AQUALINE, 1974-

Abstracts and indexes reports, journal articles, conference proceedings and preprints, monographs, pamphlets, dissertations, translations, standards, and other publications of water-related institutions worldwide. Covers all aspects of water research including wastewater and the aquatic environment. Corresponds to the printed publication *WRC Information* but contains supplementary materials. Available from DIALOG and European Space Agency.

Aquatic Sciences and Fisheries Abstracts, 1978-

Abstracts and indexes international literature on the science, technology, and management of marine and freshwater environments. Corresponds to the printed publication *Aquatic Sciences and Fisheries Abstracts; Part I: Biological Sciences and Living Resources and Part II: Ocean Technology, Policy,* and *Nonliving Resources*. Updated monthly. Produced by the United Nations with input from the U. S. and other governments. Available from BNDO, DIALOG, DIMDI, and QL Systems

Inorganic and Fertilizer Chemicals, 1947-

Has more than 1000 time series (monthly, quarterly, and yearly) on the production, inventories, plant capacity, imports, exports, prices, and shipping quantities of U. S. and Canadian agricultural chemicals. Available from SAGE DATA.

AGRICOLA, 1970-

An index to the world's agricultural literature, this data base consists of the catalog of the National Agricultural Library, the Bibliography of Agriculture, and the catalog of the Food and Nutrition Information and Education Resources Center. Covers agriculture in its broadest sense. Produced by the USDA. Updated monthly; has almost 2 million entries. Available from BRS, DIALOG, DIMDI, and SDC/ORBIT.

AGNET, numerical and textual data

A series of data bases containing data on commodity-market activity, agricultural production and trade, agricultural trade leads, USDA Economic Research Service Outlook and Situation Reports, and news reports on agricultural topics. U. S. and foreign data. Available from AGNET (University of Nebraska at Lincoln).

ONSITE, numerical data

Makes available aggregated data from the 1970 and 1980 census of the U. S. population along with estimates of other population data derived from special cenuses conducted by the Bureau of the Census. Data can be used at the state, county, ZIP-code, SMSA, city, township, or census-tract level or for geographic areas of user-specified shape and size. Available from STSC.

PESTDOC (Pest Control Literature Documentation), 1968-

Abstracts and indexes the worldwide journal literature on pesticides, plant protection, and agricultural chemicals. Available from Derwent and SDC/ORBIT.

Pollution Abstracts, 1970-

Abstracts and indexes worldwide literature on pollution research, sources, and controls. Corresponds to the printed publication of the same name. Available from BRS, DIALOG, and European Space Agency.

Federal Register Search System, 1977-

NIH/EPA's file to index environmental information in the Federal Register and to provide an abstract of that information. Contains more than 100,000 records. Updated weekly. Available from NIH/EPA Chemical Information System.

SITE II, numerical data

Has data from the 1960, 1970 and 1980 U.S. censuses of population and housing with current-year updates and five-year forecasts. Data are retrievable by state, county, SMSA, or ZIP ccode or by specifying a latitude and longitude. Available from American Management Systems, Chase Econometrics/Interactive Data, CompuServe, Computer Sciences Corp., Control Data Corp. Business Information Services, Comshare, General Electric Information Systems, Tymeshare, and United Information Services.

Impress, numerical data

Contains U. S. census data, public opinion data, election surveys, the City-County Data Book information, and anthropological and land-use studies' results, primarily dealing with the United States. Available from Dartmouth College.

DMS, numerical data

Includes USGS, EPA, and NOAA water-quality and hydrologic data along with software that allows the user to analyze the data and determine a land segment's hydrologic response, the resulting channeling of runoff, and momentum equations. Available from Hydrocomp, Inc.

IFIS, current data

Contains records on state and federal water laws, especially those that apply to the protection of instream uses of water. Has summaries of statutes, court decisions, regulations, scholarly articles, and official decrees. Available from U. S. Fish and Wildlife Service.

Instructional Resources Information System (IRIS) 1979-

Produced by the EPA, this data base provides brief abstracts and indications of availability of print and non-print educational materials on water quality and water resources. Corresponds to the printed source *Water Quality Instructional Resources Information Systems*. Updated semiannually. Available from BRS and DIALOG.

National Environmental Data Referral Service (NEDRES), 1974-

Compiled by NOAA, this bibliographic and textual data base describes more than 13,000 U.S. and Canadian sources of publicly available environmental data, including computerized data bases, printed materials, and organizations that disseminate environmental data. Topics covered include climate, meteorology, oceanography, geology, geography, and hydrology. Describes data, notes availability, identifies contacts, and cites available user aids. Updated quarterly. Available from BRS.

NAWDEX, current data

This resource is a system of textual and numeric data bases compiled by the USGS. Supplies information on organizations that share water data and on sites at which water data are collected throughout the nation. Available from U. S. Geological Survey.

Oceanic Abstracts, 1964

Abstracts and indexes publications of federal agencies and their contractors.

RECENT BIBLIOGRAPHIES AND REVIEWS

G. B. Collins, *Selected Bibliography on the Periphyton, 1982,* Environmental Monitoring and Support Lab., Cincinnati, Ohio, Report No. EPA-600/D-83-088 (1982)

Environmental measurements are required to determine the quality of ambient water, the character of effluents, and the effects of pollutants on aquatic life. The Laboratory conducts an agency-wide quality assurance program to assure standardization and quality control of systems for monitoring water and wastewater. The effectiveness of measures taken to maintain and restore the biological integrity of the Nation's surface waters is dependent upon our knowledge of the changes in the taxonomic composition of aquatic life caused by discharges of toxic substances and other pollutants, and upon the level of our understanding of the complex relationships that prevail in aquatic ecosystems. The periphyton is the community of organisms growing on natural or artificial substrates in water. This community is of particular value in assessing changes in water quality in streams since it is stationary and thus is continuously exposed to the water flow.

P. DeVore, *Annotated Bibliography of Environmental Research Conducted Within the St. Louis River Estuary 1903-1982,* Minnesota Univ.-Duluth., Report No. EPA-600/3-83-092 (Jan. 1983)

This annotated bibliography is intended as a tool for individuals attempting to locate specific types of studies conducted within the St. Louis River estuary. Each review includes the study dates, specific analyses conducted, and the location within the estuary. All reviews are indexed by subject classes: benthos, birds, fish, fish contaminants, microbiology, physical processes, phytoplankton, sediment chemistry, vegetation, water quality, and zooplankton.

JRB Associates, *Review of Literature on Herbicides, Including Phenoxy Herbicides and Associated Dioxins: Vol. 2, Annotated Bibliography,* Veterans Administration, Washington, D.C., 1981

Includes 1,200 citations to articles and publications on the environmental fate and toxicity of herbicides, particularly phenoxy herbicides, including "Agent Orange," and related dioxins used in South Vietnam.

U. S. Department of Agriculture, *List of Available Publications of the United States Department of Agriculture,* USGPO, Washington, D.C., 1980

Tells how to order information products. Lists publications by subject matter. Lists publications available from NTIS. Indexes publications by subject and by title. Issued biennially.

National Technical Information Service, *Environmental Impacts: Computer Analysis. 1976-March 1984 (Citations from the Energy Data Base; Rept. for 1976-Mar 84),* National Technical Information Service, Springfield, Va., 1984

This bibliography contains citations concerning computerized simulation and mathematical modeling, computer programs and calculations, and computer-aided design for the determination, evaluation, and specification of environmental impacts related to various human activities (commercial, recreational, and governmental) and equipment and systems associated with these activities. Emphasis is on the environmental impact of underground and surface mining, coal gasification plants, and other energy-related subjects. Contains 234 citations, 58 of which are new entries to the previous edition.

***Bibliography on Air Pollution and Acid Rain Effects on Fish, Wildlife, and Their Habitats,* Dynamac Corp., Rockville, Md. (Mar. 1982)**

This bibliography results from the development of nine reports synthesizing information from scientific research related to the effects of air pollution and acid deposition on fish and wildlife. The reports cover deserts, steppes, forests, grasslands, lakes, tundra, alpine meadows, rivers, streams, urban ecosystems, and critical habitats of threatened and endanged species.

***List of Published Soil Surveys,* Soil Conservation Service, Washington, D.C., 1978**

This publication lists all soil surveys taken by the Service since 1899 and gives the date of each survey. Organized geographically.

K. Bub et al., *Assessment of the Relationship Among Acidifying Depositions, Surface-Water Acidification, and Fish Populations in North America. Vol. 2. Bibliography. Final Report,* Western Aquatics, Inc., Laramie, Wyo., Report No. EPRI-EA-3127-V.2 (June 1983)

This bibliography compiles 1494 citations indexed by authors, keywords, geographical areas, and taxonomic groups. Literature included in the bibliographies is (1) field studies on the effects of acidifying atmospheric depositions on fish and aquatic ecosystems; (2) laboratory studies on responses of fish and other aquatic organisms to acidity; (3) field studies on other sources of aquatic acidification that can have direct application in understanding the environmental impacts of acidifying depositions; (4) documented fish kills that have resulted from aquatic acidification events; (5) research on influences of acidity and selected water quality parameters on toxicities of metals and other substances to aquatic organisms; and (6) literature that provides historical and/or trend information for water quality in many areas considered to be sensitive to acidifying depositions.

H. H. Allen and L. R. Aggus, *Effects of Fluctuating Reservior Water Levels on Fisheries, Wildlife, and Vegetation; Summary of a Workshop, 24-26 February 1981 (Final rept.)*, Army Engineer Waterways Experiment Station, Vicksburg, Miss., Report No. WES/MP/E-83-2 (July 1983)

For many years, large reservoirs have been constructed throughout the United States to provide flood control, power sources, and recreation areas. Design and operational characteristics of these reservoirs determine the types of habitat available to fish and wildlife species. Periodic fluctuations in water level on reservoirs are of particular concern to natural resource managers. The seasonal fluctuations that occur on many lakes and flood-control reservoirs and the daily fluctuations that are necessary on some hydroelectric projects often result in elimination of shoreline vegetation, which causes erosion, diminished water quality, and habitat loss or degradation. This report presents abstracts of papers presented at a workshop organized to identify the problems resource managers face and to present research results that might be applied to alleviate or moderate the adverse effects of reservoir fluctuation. Sessions were organized under the general topics of vegetation, wildlife, and fisheries.

F. van der Leeden, *Ground Water, A Selected Bibliography*, 2nd ed., Water Information Center, Port Washington, N.Y., 1974

Contains about 1750 references under 32 topics (e.g., well logging, tracers, and groundwater environments). Within these, listed alphabetically by author. Bibliographies, books and journals, and bulletins are listed separately. No annotations. No indexes or cross references.

G. R. Ploskey, *Fluctuating Water Levels in Reservoirs: An Annotated Bibliography on Environmental Effects and Management for Fisheries*, Fish and Wildlife Service, Fayetteville, Ark., Report No. WES-TR-E-82-5 (May 1982)

This report contains 367 annotations describing the effects of fluctuating reservoir water levels on fish. Citations on phytoplankton, zooplankton, and water quality that pertain to reservoir fisheries are also included. An index to facilitate location of references dealing with specific topic areas is included as an appendix.

T. Highland and C. Curtis, *Freshwater Findings, 1979-1982: Research Publications of the Environmental Research Laboratory, Duluth, Minnesota*, Environmental Research Lab., Duluth, Minn., Report No. EPA-600/X-84-003 (Oct. 1983)

This report contains citations of publications for the years 1979-1982 on research conducted or supported by the Environmental Research Laboratory-Duluth. All published material has been organized into two major categories: (1) Journal Articles, Book Chapters, Proceedings, etc., and (2) EPA Research Reports. The report is organized by year with all journal articles, book chapters, proceedings, etc., for a given year appearing before the EPA research reports for the same year; within each category publications are listed alphabetically by author. Authors of the publications listed include ERL-Duluth laboratory staff members and scientists at universities, and industry, and at other facilities who received research funding under the auspices of the Environmental Research Laboratory-Duluth.

National Technical Information Service, *Pesticide Toxicity in Aquatic Environments (Citations from the Selected Water Resources Abstracts Data Base)*, National Technical Information Service, Springfield, Va., annual

This continuing bibliography, which appears roughly on an annual basis, contains citations concerning pesticide toxicity in aquatic environments. Bioaccumulation of toxic substances, the mechanisms of action of these substances, and assay methods to determine their effects are considered. The synergistic effects of combinations of chemical agents are also addressed.

L. V. Parker, et al., *Corps of Engineers Land Treatment of Wastewater Research Program, An Annotated Bibliography*, Cold Regions Research and Engineering Lab., Hanover, N.H., Report No. CRREL-SR-83-9 (Apr. 1983)

This bibliography contains publications of research funded in whole or in part by the Corps of Engineers Land Treatment Research Program, conducted from January 1972 to May 1982. The major objective of the program was to provide, through research, definitive criteria and procedures to enable the cost-effective and environmentally safe use of land treatment of municipal wastewater. This bibliography covers technical publications on regional planning, site selection, design procedures, mechanisms of wastewater renovation, site management, site monitoring, and environmental effects. The program was officially complete in October 1980. Six types of publications are included: publications in open literature (which may include papers in journals, chapters in books and books), technical reports, engineer technical letters, draft translations (mainly from Russian), theses and dissertations (M.S., Ph.D.), and presentations at scientific conferences.

National Technical Information Service (NTIS) of the U.S. Department of Commerce

One of the primary sources of published and custom literature searches is the National Technical Information Service (NTIS) of the U.S. Department of Commerce. NTIS published searches are developed by information specialists and contain full bibliographic citations. Over 3,000 are currently available. An alphabetical listing of some of them that might be of interest to persons concerned with nonpoint source pollution is given below. In addition to the topic area, other information provided includes the time period covered, the number of bibliographic entries, the NTIS order number, and the data base used for the search (e.g., SWRA is Selected Water Resources Abstracts, EDB is Energy Data Base, etc.). At the present time the cost of any published search is only $40.00.

* Acid Mine Drainage Oct 78-May 83 (108)
PB83-807297/CAI NTIS

Acid Mine Drainage 1977-Nov 83 (197)
PB84-853696/CAI SWRA

Agricultural Watersheds 1977-Mar 83 (178)
PB83-862391/CAI SWRA

Aquatic Bacteria: Their Influence on the Aquatic Environment 1977-Jun 84 (130)
PB84-870542/CAI SWRA

Aquatic Population Dynamics 1978-Jun 84 (175)
PB84-868074/CAI SWRA

* Cadmium Pollution Nov 80-Apr 83 (247)
PB83-806505/CAI NTIS

* DDT, DDD, and DDE Pesticides 1977-Mar 83 (219)
PB83-804963/CAI NTIS

* Ecology of Insecticide Water Pollution 1978-May 84 (246)
PB84-868314/CAI NTIS

Effects of Land Use and Urbanization on Water Resources and Water Quality 1977-Aug 81 (193)
PB83-802512/CAI NTIS

Environmental Impacts: Computer Analysis 1976-Mar 84 (234)
PB84-864867/CAI EDB

Environmental Impacts: Computer Analysis 1970-Jul 84 (274)
PB84-872548/CAI NTIS

Eutrophic Lakes 1978-1983 (103)
PB84-861038/CAI SWRA

* Eutrophication Dec 81-Feb 83 (39)
PB83-804625/CAI NTIS

Ground Water Aquifers 1977-Jan 83 (193)
PB83-859926/CAI SWRA

Ground Water Pollution 1964-Mar 83 (210)
PB83-807693/CAI API

* Ground Water Pollution: General Studies May 1981-Dec 82 (190)
PB83-802207/CAI NTIS

* Ground Water Pollution: Pollution from Irrigation and Fertilization 1977-Sept 82 (206)
PB83-800433/CAI NTIS

Groundwater Pollution Monitoring 1976-Jan 84 (153)
PB84-860022/CAI EDB

Microbiology of Groundwater 1978-May 84 (53)
PB84-867357/CAI LSC

Microbiology of Groundwater 1977-May 84 (105)
PB84-867365/CAI SWRA

Modeling Aspects of Estuarine Eutrophication 1977-1983 (97)
PB84-860550/CAI SWRA

Paraquat Toxicity 1978-1983 (174)
PB84-854009/CAI LSC

* Pesticide Toxicity in Aquatic Environments Jun 83-Apr 84 (52)
PB84-865351/CAI SWRA

Remote Sensing Applied to Environmental Pollution Detection and Management 1964 Jan 83 (224)
PB83-803882/CAI NTIS

Soil Salinity: Irrigation Practices and Effects on Crops and Groundwater 1977-Mar 84 (118)
PB84-863901/CAI SWRA

Strip Mining: Hydrology 1977-1983 (204)
PB84-854199/CAI SWRA

Strip Mining: Impacts on Water Resources 1977-Jun 83 (103)
PB83-867200/CAI SWRA

Water Pollution: Uptake of Heavy Metals by Shellfish and Marine Plants 1974-1983 (248)
PB84-854306/CAI OCEANIC

Water Quality: Pathogenic Bacteria 1977-Jun 84 (205)
PB84-857812/CAI SWRA

* Water Resources and Water Quality: Effects of Land Use and Urbanization Sep 83-Nov 82 (64)
PB83-802520/CAI NTIS

Animal Waste Pollution and its Control 1970-Apr 84 (272)
PB84-866524/CAI NTIS

Animal Waste Pollution, Treatment, and Regulations 1977-Jun 84 (303)
PB84-869692/CAI SWRA

Eutrophication: Water Quality and Pollution Control 1970-Jan 84 (140)
PB84-860923/CAI Ei

Eutrophication: Water Quality and Pollution Control 1978-1983 (108)
PB84-861533/CAI POLLUTION

Percolation Techniques for Water Quality Control and Waste Treatment 1977-Oct 83 (314)
PB84-851658/CAI SWRA

Treatment of Leachate 1977-1983 (65)
PB84-862564/CAI SWRA

Automatic Acquistion of Water Quality Data 1978-Jan 82 (297) Includes techniques, planning, and equipment design
PB83-806257/CAI NTIS

* Automatic Acquisition of Water Quality Data Feb 82-Apr 83 (103) Includes techniques, planning, and equipment design
PB83-806265/CAI NTIS

* Bioindicators of Pollution Nov 77-Apr 83 (214)
PB83-805341/CAI NTIS

Pollution Detection Jun 70-Apr 83 (222)
PB83-864017/CAI NTIS

Toxicity Bioassays: Water Pollution Effects on Aquatic Animals and Plants 1977-Apr 84 (214)
PB84-865534/CAI SWRA

Water Pollution Effects of Metals on Fresh Water Fish 1964-Mar 83 (187)
PB83-804872/CAI NTIS

Hydrologic Cycle: Water Supply and Water Quality 1977-Jan 84 (132)
PB84-862226/CAI SWRA

* Sediment Transport in Rivers 1978-Mar 84 (119) Excludes lakes and resevoirs
PB84-864362/CAI NTIS

* Sediment-Water Interactions and Their Effects Upon Water Quality 1979-Mar 84 (78) Excludes salt water studies
PB84-861822/CAI NTIS

Stream Flow Routing and Forecasting: Computer Simulation and Analyses 1977-May 83 (127)
PB83-865493/CAI SWRA

Synthetic Hydrology 1977-May 83 (279)
PB83-864942/CAI SWRA

* Water Quality Modeling: Hydrological and Limnological Systems Oct 81-Jan 83 (17)
PB83-802991/CAI NTIS

* Water Quality Modeling: Hydrological Systems Apr 83-Jan 84 (78)
PB84-861665/CAI SWRA

Computerized Management and Simulation of Groundwater Resources 1977-Jun 84 (304)
PB84-869346/CAI SWRA

Conjunctive Use of Groundwater and Surface Water 1977-Sep 83 (71)
PB83-872382/CAI SWRA

Recreation Demand: Water Resources 1977-May 84 (98)
PB84-864891/CAI SWRA

Recreation Facilities: Water Resources 1977-May 84 (172)
PB84-864990/CAI SWRA

Remote Sensing Applied to Hydrology 1964-Jan 83 (270)
PB83-803676/CAI NTIS

Agricultural Watersheds 1977-Mar 83 (178)
PB83-862391/CAI SWRA

Forest Watersheds 1977-1982 (183)
PB83-857771/CAI SWRA

HANDBOOKS, MANUALS, AND CATALOGS

S. McKenzie, L. Milask, and R. Long, *Feasibility Study for an Air Force Environmental Model and Data Exchange, Volume 3, Appendix F. Model Review and Index-Water Models, (Final rept. Mar 81-Feb 83), General Software Corp., Landover, MD., Report No. AFESC/ESL-TR-82-13-VOL-3, (July 1983)*

The overall study assesses Air Force needs and capabilities for environmental consequence modeling, Air Force model application capabilities, and resources available to overcome identified deficiencies. A brief introduction to water models, by application category, precedes an extensive directory of water quality and quantity models. Reviews of models presented include (in general): (1) model name, (2) sponsor/developer, (3) contact, (4) model availability, (5) model abstract, (6) citation references, (7) current user, (8) implementation hardware/software, (9) input references, (10) output products, (11) synopsis of major parameters.

A. Mitchell, B. H. Dodge, P. G. Kruzie, D. C. Miller, P. Schwartz, and B. E. Suta, *Handbook of Forecasting Techniques*, SRI International, Menlo Park, Calif., 1975

Twelve basic forecasting techniques are described and case examples of each are given. The twelve methods are trend extrapolation, pattern identification, probabilistic forecasting, dynamic models, cross-impact analysis, KSIM, input-output analysis, policy capture, scenarios and related methods, expert-opinion methods, alternative futures, and values forecasting. The description of each method includes a definition of the method, assumptions made in its use, the history of its development, its main uses, its limits and the cautions that must be exercised in its use, related forecasting techniques, the product or results, the level of confidence that can be expected, the ability of the method and its results to be explained and understood, the credibility of the results, the span of the forecast that can be produced, the resources needed to employ the method, and the procedures employed in performing the forecast with this method. A glossary and a general index are provided.

President's Council on Environmental Quality, *Environmental Statistics 1978*, NTIS, Springfield, Va., 1979

A book of ~200 tables of environmental timeseries data that are important in understanding the nature and quality of the environment. Grouped by topic (e.g., population growth, solid waste, forests, wildlife, and water resources). Indexed by subject.

Council on Environmental Quality, *Environmental Trends*, USGPO, Washington, D.C., 1981

This publication shows trends in data concerning the environment with graphic presentations coupled with explanatory and analytical texts. The data give current and historic values for statistical measures of wetlands, wild areas, parks, historic places, risk zones, human settlements, transportation, use of materials, solid waste, pesticides, industrial chemicals, hazardous metals, radiation, cropland, forests, rangeland, wildlife, energy, water resources, rivers and streams, lakes, oceans, air quality, population, land use and cover, and the atmosphere. Indexed by subject.

U.S. Bureau of the Census, *Bureau of the Census Catalog*, USGPO, Washington, D.C., annual

Introductory material gives overview of Census operations and the storage and dissemination of Census information. Main entries grouped by subject (e.g., agriculture, population, and geography). All publications listed and described. Appendixes given information about subscriptions to Bureau of the Census publications, late-breaking publications and data files, and sources of additional information within the Bureau of the Census. Subject index.

H. T. Frey, *Major Uses of Land in the United States*: 1974, Agricultural Economic Report No. 440, USGPO, Washington, D.C., 1979

Every five years the Department of Agriculture publishes this report on the major uses of land in conjuction with the quinquennial Census of Agriculture. The study presents estimates of the area of cropland, pasture and rangeland, forest land, urban areas, transportation areas, recreation and wildlife areas, national defense areas, farmsteads and farm roads, and miscellaneous lands. Type of ownership is also analyzed, and trends of use are discussed. Numerical data by state and region are presented tabularly in an appendix.

***List of Chemical Compounds Authorized for Use Under USDA Inspection and Grading Programs*, USGPO, Washington, D.C., annual**

This work lists the cleaning agents, disinfectants, pesticides, and other products approved for use in processing meat and eggs. Entries are grouped by marketing company and then alphabetically by trade name.

EG&G Washington Analytical Services Center, *Handbook of Federal Systems and Services for Marine Pollution Data and Information*, National Oceanic and Atmosphere Administration, Washington, D.C., 1983

This handbook describes 64 federal information systems that collect and disseminate information related to marine pollution. Each entry gives the name and address of the system, its scope of service, its role, the types of data it contains, the quantity of data, the types of products available, the means of access, the methods of acquiring relevant data, its typical response time, approximate costs, the available hardware and software, the storage media used, and the principal contact. It is indexed by data type and by services available.

B. G. Liptak, *Environmental Engineers' Handbook, Vol. 1, Water Pollution*, Chilton Book, Radnor, Penn., 1974

The three-volume work, of which this is a part, provides complete coverage of all aspects of pollution causes, effects, and remedies. It is largely textual. It reviews and summarizes water pollution laws and regulations; water as a natural resource; types of pollutants and their effects; instrumentation for water quality and treatment; traditional wastewater treatment techniques; advanced forms of wastewater treatment; removing specific contaminants from water; and disposal and reclamation of wastes. It has a comprehensive index and a glossary.

***Wetlands: Their Use and Regulation*, Office of Technology Assessment, Washington, D.C., 1984**

This work evaluates the effects of technological activities on wetlands, technological and nontechnological options for mitigating undesired impacts, the functional values of different types of wetlands, the problems associated with weighing the benefits of technological activities in wetland areas against the functional values of the wetlands that may be lost, and various approaches to wetlands use.

***Water-Related Technologies for Sustainable Agriculture in U.S. Arid and Semiarid Lands*, Office of Technology Assessment, Washington, D.C., 1983**

This assessment focuses on the opportunities of present and emerging technologies to provide long-term sustainable agricultural productivity by increasing efficiency of water use and reducing agricultural water demands in arid and semiarid U. S. lands. The ability of such technologies to improve water quality of agriculture runoff and the associated socioeconomic impacts are also examined.

***Survey to Identify Models Used by Executive Agencies in the Policy making Process*, GAO/PAD-82-46 (Sept. 24, 1982)**

The Government Accounting Office surveyed 42 federal agencies to identify the models (representations of either real or proposed processes or systems) that are used; 357 such models were identified and are listed in this catalog. This listing is arranged by federal agency, and each entry gives the name of the model, the subject area of the model, and the name of the director of the program that uses the model. No subject index is available. The subjects covered by the models include (but are not limited to) crop supply and demand, land management, resource planning, energy demand, fuel production, health-care-personnel needs, population, wildlife habitat, water resources, carcinogenic risk, hazardous-waste disposal costs, air quality, chemical fate, and flood control. An appendix gives aggregate statistics on selected characteristics of the models, such as the length of time in use, development costs, and uses.

U.S. Department of Agriculture, *Agricultural Statistics*, USGPO, Washington, D.C, annual

An annual reference book on agricultural production, supplies, consumption, facilities, costs, and returns. Most time series carried back to 1965. Has data on foreign countries as well as United States. Arranged by agricultural product (grains, fruits, etc.) and by agricultural topic (farm economics, taxes, etc.). Indexed by subject.

U.S. Department of the Interior, Water Research and Technology Office, *Water Resources Research Catalog, Vol. 11, USGPO*, Washington, D.C., 1977

Describes about 5000 research projects being conducted by federal, state, and local governments; industries; and academic institutions. Indexed by subject.

J. A. Ruffner, *Climates of the States*, Gale Research, Detroit, 1978

State by state, the climatography of the states is reviewed in a brief narrative; freeze data are tabulated; normal mean and extreme weather data are given tabularly for each weather station (for 1931-1960 and for 1941-1970); isolines are drawn on maps to show mean maximum and minimum temperatures in January and July; isolines are also used to show mean annual precipitation; and a map of recording stations is given. Data on tropical storms and a description of the State Climatological Program are included.

Bureau of the Census, *1980 Census of the Population*, USGPO, Washington, D.C., 1983

This work presents tabular and graphic data on age, fertility ratio, material status, and other characteristics of the U. S. population in 57 parts. The different parts each cover the United States as a whole, a state, a trust territory, or other division. Each part is divided into several volumes. The first volume has chapters on the number of inhabitants, the characteristics of the general population, the general social and economic characteristics of the general population, and detailed characteristics for the area described. The other volumes contain subject reports on such topics as employment status, work experience, and census-track statistics. A multivolume Users' Guide is published also. It gives a narrative explanation of the compilation and publication of census data, a glossary, summary descriptions of available tape files, and other aids.

Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1970*, USGPO, Washington, D.C., 1975

This is a massive compendium of statistics for the United States on such topics as population; vital statistics; land, water, and climate; agriculture; forestry and fisheries; minerals; and energy. Some statistical series extend back to the seventeenth century. The statistics are often broken down by state, age, race, or other variable. Thoroughly indexed by subject and by time period.

Bureau of the Census, *Statistical Abstracts of the United States*, USGPO, Washington, D.C., annual

A compilation of recent statistics about the United States related to population, vital statistics, health, geography and environment, parks and recreation, energy, forests and forest products, fisheries, mining and mineral products, and other subjects. Many of these tables of data are linked to historical series reported in *Historical Statistics of the United States, Colonial Times to 1970*. Appendixes explain statistical methodology and reliability, present guides to sources of statistics, give selected characteristics of congressional districts, and offer other information. Heavily indexed by subject.

J. A. Ruffner and F. E. Blair, *The Weather Almanac*, Gale Research, Detroit, 1981

A compilation of data on the weather, climate, and air quality in the United States and its major cities. Presents statistics, principles, and terminology about weather and climatology. Describes sources of current information on the weather.

Bureau of Economic Analysis and the U.S. Water Resources Council, *1980 OBERS BEA Regional Projections*, USGPO, Washington, D.C., 1981

This handbook presents projections of economic activity for the nation, states, Bureau of Economic Analysis economic areas, Standard Metropolitan Statistical Areas, and substate areas. Projections to the year 2030 are presented for population, personal income, and employment and earnings. The work appears in 11 volumes. Volume 1 presents state projects and the underlying historical data of all of the projections, a detailed discussion of the concepts and methods used in preparing the projections, summary tables of data for the nation, and appendixes describing the statistical concepts and industrial groups used. Volume 2 presents data for the BEA economic areas (New England, Mideast, Great Lakes, Plains, Southeast, Southwest, Rocky Mountain, Far West, and Hawaii and Alaska); Volume 3 for the SMSAs; and Volumes 4 through 11 for substate areas. All data are also available on computer tapes from the BEA. The use of the acronym OBERS reflects the cooperation between the former

***Water Resources Data*, USGS, Alexandria, Va., annual**

The USGS publishes annually a water resources data report for each state, Puerto Rico, and the trust territories. These data include floods, mean flow, low flow, surface-water quality, groundwater levels, groundwater quality, and other data gathered from the USGS's surface and groundwater data collection networks. Indexed by geographic location.

R. J. Olson, C. J. Emerson, and M. K. Nungesser, *Geoecology: A County-Level Environmental Data Base for the Coterminous United States*, ORNL/TM-7351 (Sept. 1980)

This publication is a manual on the use of the Geoecology Data Base, an integrated data base of diverse environmental resource information. It was developed from extant sources of data. The data are stored at the county or subcounty level. The data base contains data on terrain, soils, water resources, forestry, vegetation, agriculture, land use, wildlife, air quality, climate, natural areas, endangered species, and human population. It was funded to support DOE research projects. Access to others has been provided on a cost-recovery basis.

A. E. Greenberg, M. J. Taras, and W. C. Rand, *Standard Materials for the Examination of Water and Wastewater*, 14th ed., Am. Public Health Assoc., AM. Water Works Assoc., and Water Pollution Control Fed., Washington, D.C., 1976

Describes the theory and use of the standard methods adopted by the three publishing agencies for the examination of domestic or industrial water supplies, surface or groundwaters, boiler waters, and treated and untreated wastewaters. Covers physical, chemical, biological, and microbiological examinations. Illustrated sections aid the identification of aquatic organisms and algae. Indexed by subject.

MAPS, DRAWINGS, AND OTHER GRAPHIC INFORMATION

J. J. Geraghty, D. W. Miller, F. van der Leeden, and F. L. Troise, *Water Atlas of the United States*, Water Information Center, Port Washington, N.Y., 1973

Presents 122 maps graphically portraying national water data on water quality, water pollution, water law, water-based recreation, water conservation, weather, water distribution and availability, and other topics. Data have been compiled from many governmental and nongovernmental sources and have been normalized and arrayed for easy comparison and assimilation. The work covers all 50 states.

H. F. Lins, Jr., *Patterns and Trends of Land Use and Land Cover on Atlantic and Gulf Coast Barrier Islands*, USGS Professional Paper 1156, USGPO, Washington, D.C., 1980

The main content of this publication is a series of maps covering selected areas along the coastline from Maine to Texas. These maps indicate the land use and land cover of the areas shown. Changes in land use and land cover are quantified and presented tabularly in an appendix. The data are analyzed, their significance is discussed, and conclusions are drawn in the text. A cartographic index aids the reader to find maps of specific areas in the work.

Federal Committee on Ecological Reserves, *A Director of Research Natural Areas on Federal Lands of the United States of America*, Forest Service, Washington, D.C., 1977

Lists, specifies the location, gives a personal contact, notes the ownership, and details the primary features of natural areas in the United States. Ordered by state. Indexed by site index code, by primary feature, and by agency regional office. Other sections of the publication give addition information on scientific ecological reserves, reprints of Federal Committee documents, a bibliography, and a map.

J. L. Androit, *Township Atlas of the United States*, Androit Assoc., McLean, Va., 1979

This work contains a collection of maps of the minor civil divisions of all 50 states, as identified, characterized, and mapped by the Bureau of the Census in its 1970 census. Arranged by state. Also contains an index to the 46,900 names of all counties, minor civil divisions, and census county divisions. Other indexes cover populated places and urbanized areas. Indexes lead the reader to the appropriate state and county in the main entries.

DIRECTORIES

M. D. Edwards, *Directory of Assistance Centers of the National Water Data Exchange (NAWDEX)*, USGS Open-File Report 80-1193, 1980

A large number of water-oriented organizations have joined together in a federation to exchange water data, and centers have been established to aid users of water data in identifying and locating the data they need. The centers are located in 45 states and Puerto Rico. This directory names the centers and gives their addresses, telephone numbers, directors' names, and office hours. Entries are listed alphabetically by state. NAWDEX also maintains a master list of water data and where those data are available.

Library of Congress National Referral Center, *A Directory of Information Resources in the United States: Geosciences and Oceanography*, USGPO, Washington, D.C., 1981

A printed output of a subset of the Center's data base. Contains about 1000 organizations, giving the name, address, telephone number, areas of interest, type of information holdings, publications, and information services available. Indexed by subject.

P. T. Larson, F. Evangelista, and D. C. Dismachek, *Products and Services of the National Weather Service, National Environmental Satellite Service, Environmental Data Service, and the Environmental Research Laboratories*, NOAA, Washington, D.C., 1977

Issued in looseleaf form, this publication describes NOAA products and services that are issued periodically (anywhere from hourly to biennially) and that are available to interested organizations and individuals.

National Aeronautics and Space Administration, *Sources for Landsat Assistance and Services*, NASA, Washington, D.C., 1980

A directory of academic and commercial sources of Landsat data and products. Federal and state agencies that can provide aid in use of Landsat data are also given.

SECTION 3

ANNOTATED BIBLIOGRAPHY

This section is a rough draft of an annotated bibliography consisting of a collection of abstracts of recent publications dealing with matters believed to be of interest to those concerned with nonpoint source pollution. Available resources at the time of preparation were not sufficient for completion and refinement of this section. It is being included at this time, however, in order to obtain user reaction to the utility of such an annotated bibliography and comments on extent of coverage, scope, and categorial groupings. As a first cut, these abstracts have been grouped into 17 categories as follows:

- Rainfall/Runoff
- Erosion/Sediment
- Heavy Metals/Sediment Binding
- Nutrients
- Nitrate/Groundwater
- Micro-organisms
- Urban Runoff/Combined Sewer Overflow (URO/CSO)
- Agriculture
- Silviculture
- Mining
- Highway Runoff
- Best Management Practices (BMPs)
- Biological
- Sampling/Monitoring
- Data Analysis/Modeling
- Policy
- Miscellaneous

Obviously, many of the publications reviewed in this guide could fall into more than one category. For example, a study might have both characterized runoff from a particular land use/land cover as well as the performance of some best management practice. In such cases, the publications were placed in the category that the present author believed best suited the predominant theme or finding of the publication in question. In other instances, some possible categories, such as airport runoff, although extant in the literature, are so sparsely represented that a separate category did not seem justified. Such citations were placed in the closest of the 17 final categories chosen. Thus, publications on airport runoff, for example, appear in the URO/CSO category.

AN INFILTRATION BASED RUNOFF MODEL FOR A STANDARDIZED 24-HOUR RAINFALL

Agricultural Research Service, Beltsville, MD, D. L. Brakensiek, and W. J. Rawls.
Transactions of the ASAE, Vol. 25, No. 6, p. 1607-1611, November/December, 1982. 1 Fig., 4 Tab, 10 Ref.

Descriptors: *Rainfall-runoff relationships, *Rainfall infiltration, *Mathematical models, Rainfall distribution, Runoff volume, Runoff rates, Runoff forecasting, Soil texture, Soil water.

The application of the Green and Ampt infiltration equation to a standardized 24-hour rainfall distribution is described. Procedures for predicting surface runoff amount and duration are developed and illustrated through an example using the Soil Conservation Service (SCS) Type II, 24-hour rainfall distribution. Tabulated values are presented for soil infiltration parameters as a function of soil texture. The example demonstrates the application of the procedure to a given soil texture, antecedent soil water condition, 24-hour rainfall total, and a 24-hour rainfall distribution with SCS Type II distribution. Other distributions could be used, with the constraint that they are successively monotonic increasing and then decreasing. The predicted runoff amounts and durations could be used to make runoff peak rate estimates. This infiltration approach provides an improved framework for evaluating the effects of land use and practices on runoff amounts and duration. (Carroll-FRC)
W83-03961

ANTECEDENT MOISTURE CONDITION PROBABILITIES FOR SELECTED INDIANA STATIONS

Purdue Univ., Lafayette, IN School of Civil Engineering, C. R. Burke and D. D. Gray.
Proceedings of the Indiana Academy of Sciences, Vol. 92, p. 219-226, 1982. 2 Fig., 2 Tab, 18 Ref.

Descriptors: *Probability distribution, *Moisture, *Weather forecasting, Indiana, Mathematical equations, Predicting.

The analysis of 258 years of daily weather observations at 10 Indiana stations has been used to provide reliable estimates of the probability of occurrence of the Antecedent Moisture Condition classes of the Soil Conservation Service Curve Number method and the Illinois Urban Drainage Area Simulator (ILLUDAS) computer program. The uniformity of the probabilities across the state means that probabilities for any location in Indiana can be interpolated with confidence. The present results confirm and supercede the less statistically significant Antecedent Moisture Condition (AMC) probabilities published previously for fewer Indiana stations. (Baker-IVI)
W84-05308

AREAL REDUCTION FACTORS ON SHORT TIME AND SPACE INTERVALS

Montpellier-2 Univ. (France). Lab. d'Hydrologie Mathematique, M. Desbordes, P. Raous, and Y. Trevisiol.
Water Science and Technology, Vol. 16, No. 8/9, p. 189-198, 1984. 3 Fig., 4 Tab, 3 Ref.

Descriptors: * Areal precipitation, *Rainfall-runoff relationships, *Rungis, *France, Rainfall intensity, Drainage area, Intensity-duration-frequency curves.

In most research studies on rainfall-runoff, processes, rainfall intensities over the experimental catchments are measured by means of a few rain gages. An experimental dense rain gage network on the Rungis catchment, France, composed of 9 rain gages, covering approximately 300 to 400 hectares, was monitored for three years. Areal reduction factors on short time and space intervals were determined from 51 events ranging from 5 minutes to 4 hours. Mean rainfall intensities should not be considered to be uniformly distributed over small areas ranging from 100 to 400 hectares and for durations less than one hour. For storm drainage design purposes, one should remember that areal reduction factors are random variables; the areal distribution of rainfall should be taken into account by means of Areal Intensity-Duration-Frequency curves. If these are unknown, one should use mean areal reduction factors defined from point rainfall, rather than mean reduction factors which are defined from maximum point rainfall, observed over a given area. Rainfall-runoff balances at the catchment outlet have confirmed the influence of rain gage network density. The minimum 50 to 100 hectares mesh size seems to be suitable. (Collier-IVI).
W85-01690

ASSESSMENT OF THE SPATIAL VARIATION IN THE CHEMICAL COMPOSITION OF BULK PRECIPITATION WITHIN AN UPLAND CATCHMENT

Institute of Terrestrial Ecology, Bangor (Wales), B. Reynolds.
Water Resources Research, Vol. 20, No. 6, p. 733-735, June, 1984, 1 Fig, 2 Tab, 16 Ref.

Descriptors: *Precipitation chemistry, *Catchment areas, *Wales, Elevation, Aspect, Potassium, Collectors, Sampling.

Six bulk precipitation collectors were installed at four sites in the Cyff catchment and at two sites in the Gwy catchment of the Upper Wye on the eastern slopes of Plynlimon in Wales. Bulk precipitation was collected weekly for chemical analysis over a period of 64 weeks at the six sites. For this remote uninhabited upland catchment, aspect and elevation appear to have little influence on the chemical

composition of bulk precipitation. At this site, a single collector is adequate for estimating solute concentrations in bulk precipitation to within + or − 10% of the true mean for all ions except potassium, which would require two collectors. Additional collectors might be deployed to cope with sample contamination. To be within + or − 5% of the true mean, a large number of collectors, up to a maximum of 8 for potassium would be necessary. The variations in rainfall catch and its dependence on elevation must also be taken into account for calculating the total input of solutes to moderate-sized catchments. (Moore-IVI)
W85-01348

ATMOSPHERIC CONTRIBUTIONS TO STREAM WATER CHEMISTRY IN THE NORTH CASCADE RANGE, WASHINGTON

D. P. Dethier, *Water Resources Research*; 15: No. 4, 787-794 (1979).

Bulk precipitation contributes significant quantities of cations and trace metals to a subalpine catchment located in the North Cascade Range of Washington. Precipitation loadings account for 30% of the major and more than 50% of the minor element export from the catchment. Preliminary data from larger basins in the North Cascades suggest similar values. Calcium and potassium measured in bulk precipitation are largely derived from continental dusts, while sodium and magnesium originate as marine aerosols. Lead, copper, and arsenic, products of anthropogenic activity in the Puget lowland, are deposited downwind in the Cascade Mountains; mean precipitation pH at the study site was 4.85 during 1974 and 1975. Elements contributed by precipitation become part of complex upland biogeochemical cycles. With the exception of highly mobile ions like sodium, elemental levels in streamflow reflect biologic and pedogenic cycling processes rather than direct precipitation influence.

CALIBRATION AND VERIFICATION OF A RAINFALL-RUNOFF MODEL AND A RUNOFF-QUALITY MODEL FOR SEVERAL URBAN BASINS IN THE DENVER METROPOLITAN AREA, COLORADO

Geological Survey, Lakewood, CO. Water Resources Div., J. B. Linder-Lunsford and S. R. Ellis.
Available from the OFSS, USGS, Box 25425, Fed. Ctr. Denver, CO. 80225, USGS Water Resources Investigations Report 83-4286, 1984. 52 p. 6 Fig. 26 Tab, 7 Ref.

Descriptors: *Model studies, *Urban runoff, *Water quality, *Colorado, Denver, Jefferson County, Arapahoe County, Adams County, Denver County.

The U. S. Geological Survey's Distributed Routing Rainfall-Runoff Model-Version II was calibrated and verified for five urban basins in the Denver metropolitan area. Land-use types in the basins were light commercial, multifamily housing, single-family housing, and a shopping center. The overall accuracy of model predictions of peak flows and runoff volumes was about 15 percent for storms with rainfall intensities of less than 1 inch per hour and runoff volume of greater than 0.01 inch. Predictions generally were unsatisfactory for a storm having a rainfall intensity of more than 1 inch per hour, or runoff of 0.01 inch or less. The Distributed Routing Rainfall-Runoff Model-Quality, a multi-event runoff-quality model developed by the U. S. Geological Survey, was calibrated and verified on four basins. The model was found to be most useful in the prediction of seasonal loads of constituents in the runoff resulting from rainfall. The model was not very accurate in the prediction of runoff loads of individual constituents. (USGS)
W85-02044

CHEMICAL COMPOSITION OF BULK PRECIPITATION IN THE NORTH-CENTRAL AND NORTHEASTERN UNITED STATES, DECEMBER 1980 THROUGH FEBRUARY 1981

Geological Survey, Albany, NY. Water Resources Div., N. E. Peters and J. E. Bonelli.
Available from the Br. of Dist. USGS, 604 S. Pickett St. Alexandria, VA 22304. Geological Survey Circular 874, 1982. 63 p., 20 Fig., 5 Tab, 28 Ref.

Descriptors: *Chemistry of precipitation, *Snow, *Deposition, *Chemical analysis, Trace metal, Snow samplers, Sampling, Sites, *Bulk precipitation, North-central United States, Northeastern United States.

Bulk precipitation samples were collected at 180 sites in the north-central and north-eastern States for 3 months during winter 1980-81 to provide data on the distribution of chemical constituents. Concentrations and average daily loads of 28 dissolved constituents were determined. Sodium and chloride deposition was relatively high in coastal areas and near some urban centers. Regional patterns of hydrogen ion, nitrate, lead, and iron loading correlate well with each other and form a concentric pattern around the center of high deposition in eastern Ohio and western Pennsylvania, suggesting an urban-industrial source. Samples from this area had low pH (< 4.2), whereas samples from southern Minnesota and Illinois had circumneutral pH (< 5.7). The latter samples had high concentrations of calcium and total inorganic carbon, suggesting pH control by soil-derived carbonate minerals. Deposition patterns of ammonium, nitrate, and sulfate display regional highs in Illinois, Indiana, and southwestern Michigan, suggesting agricultural sources such as fertilizer. Median loads of zinc, iron, and lead were lower than reported in previous studies for North America. The apparent decrease in lead since 1950 throughout the area is attributed to reduced consumption of leaded fuels and lower deposition in winter. (USGS)
W83-02968

CONFIDENCE INTERVALS FOR DESIGN EVENTS

Cornell Univ., Ithaca, N.Y., Dept. of Environmental Engineering, J. R. Stedinger.
Journal of Hydraulic Engineering, Vol. 109, No. 1, p.

13-27, January, 1983. 1 Fig, 10 Tab, 25 Ref. NSF grant CME 8010889.

Descriptors: *Confidence intervals, *Design criteria, *Floodplain management, Quantile, Flood flow, Pearson Type III distributions, Mathematical equations, Mathematical models, Mathematical studies, Flood frequency.

An important problem in hydrology is the estimation of some quantile of a streamflow or flood-flow distribution. For example, the 100-year flood, corresponding to the 99 percentile of the annual floodflow distribution, is used in floodplain management and planning. Confidence intervals for normal, log-normal, and Pearson Type III quantiles based on asymptotic theory are shown to fail to contain the true 100-year flood and other design events with the specific frequency (confidence level). Intervals which contain normal and lognormal quantiles with the desired confidence can be constructed using the noncentral t-distribution. Tables are provided. An adjustment for the case when a variable has a Pearson Type II distribution with known skewness coefficient is suggested. Such intervals are shown to contain design events with nearly the desired level of confidence. Confidence intervals constructed using the U. S. Water Resources Council guidelines, Bulletins 17A and 17B, often did not achieve the desired confidence level. (Murphy-IVI)
W84-04821

CONTAMINANT LEVELS IN PRECIPITATION AND URBAN SURACE RUNOFF

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center M. Owe, P. J. Craul, and H. G. Halverson.
Water Resources Bulletin, Vol. 18, No. 5, p. 863-868, October, 1982. 4 Fig, 4 Tab, 22 Ref.

Descriptors: *Urban runoff, *Runoff, *Precipitation, Water pollution sources, Fate of pollutants, Metals, Hydrocarbons, Transportation, Zinc, Lead, Copper, Cadmium, Pollutant load, Fallout, *New York, Syracuse.

Heavy metals and petroleum hydrocarbons concentrations were determined in samples of precipitation and runoff collected at a shopping mall near Syracuse, New York, during 12 storms in the 1979 hydrologic year. Levels of contaminants (mg per liter) in precipitation were: Pb, 0.058-0.186; Zn, 0.047-0.183; Cu, 0.005-0.095; Cd. 0.001-004; and hydrocarbons, none. Levels of contaminants (mg per liter) in all surface runoff were: Pb, 0.74-2.97; Zn, 0.89-4.74; Cu. 0.12-1.38; Cd. 0.01-0.28; and hydrocarbons, 3.83-19.71. There was no correlation between precipitation contaminant concentration and length of antecedent dry period. A weak inverse relationship was observed between concentration and amount of precipitation. Poor correlations were obtained between runoff contaminant levels and length of antecedent dry period. However, the dryfall accumulation value, which accounted for different precipitation volumes and contaminant loads, was well correlated with length of antecedent dry period. Metal ions were probably derived from atmospheric fallout, from both distant sources and the automobile traffic at the mall. Hydrocarbon residues were solely the result of automobile losses. (Cassar-FRC)
W83-02156

DEPRESSIONAL STORAGE ON TILLED SOIL SURFACES

Agricultural Research Service, Morris, MN. North Central Soil Conservation Research Center, C. A. Onstad.
Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 3, p. 729-732, May/June, 1984. 6 Fig., 12 Ref.

Descriptors: *Depressional storage, *Soil properties, Roughness, Slope, Storage, Water supply, Mathematical equations, Precipitation excess, Rainfall-runoff relations.

A set of 1,060 independent determinations of microrelief from small plots was used in this study. These data were extrapolated to slopes ranging from 2 to 12% without altering individual values of random roughness. A complex depressional storage model utilizing individual point elevations within a plot was developed to estimate depressional storage assuming an impervious soil surface. Mode output included surface area of depressions, precipitation excess needed for 100% of the plot to produce runoff and percent of the surface area contributing runoff as a function of precipitation excess needed to fill the depressions. Because the model is cumbersome and complex and not easily used in the field, outputs are related to slope steepness and random roughness using regression techniques with good results. In general, depressional storage decreases with decreasing random roughness and increasing slope steepness. Surface area of the depressions when filled increases with random roughness for low slope steepnesses. For high slope steepness, surface area increases to a maximum value at an intermediate roughness value and then begins to decrease. The amount of precipitation excess needed to fill the depressions decreases with increasing slope steepness and decreasing random roughness. Ratios of depressional storage to precipitation excess needed to fill the depressions range from near zero to about 35% depending on slope steepness and random roughness. Examples for two plots are shown for the percent of area contributing to runoff as a function of the fraction of precipitation excess needed to fill the depressions for both relatively smooth and rough surfaces and low and high slope steepnesses. The fraction of precipitation excess contributing to runoff increases fastest for smooth surfaces on steep slopes. (Baker-IVI)
W85-03376

DESIGN INFLOW INTENSITY AND DESIGN INFLOW PROFILES FOR STORM SEWERS

Rijksdienst voor de Ijsselmeerpolders, Lelystad (Netherlands), F. H. M. van de Ven

Water Science and Technology, Vol. 16, No. 8/9, p. 207-218, 1984, 5 Fig., 5 Tab, 7 Ref.

Descriptors: *Storm sewers, *Design inflow intensity, *Design inflow profiles, *Netherlands, *Lelystad, *Sewer hydraulics, Sewers, Rainfall distribution, Discharge frequency, Depth-duration-frequency curves.

Twelve year records of rainfall and of sewer inflow data in a housing area and in a parking lot in Lelystad, The Netherlands, were available. These data series contained 5-minute depths of rainfall and sewer inflow. Depth-duration-frequency curves were calculated from the monthly extremes, using Box-Cox transformation and a Gumbel distribution. The differences between the curves for rainfall and for inflow are explained by inertia and rainfall losses. These differences are the reason to use inflow as a sewer design parameter. For the choice of the design discharge (or inflow) intensity the curves are not well suited. Storage-design, discharge-frequency curves proved to be better interpretable. The selected design discharge is 4 or 5 cu m/s/sq km. For non-steady flow calculations in sewer systems an inflow profile has to be provided. The profile should be peaked. The most common location of the peak lies between 20 and 50% of the event duration. The return period of the profile has to be known. A bivariate extreme value distribution is used to estimate this return period. From these distributions synthetic inflow profiles could be calculated. (Author's abstract).
W85-01692

DISTRIBUTION OF CATCHMENT COVERAGE BY STATIONARY RAINSTORMS

Massachusetts Inst. of Tech., Cambridge, Dept. of Civil Engineering, P. S. Eagleson.
Water Resources Research, Vol. 20, No. 5, p. 581-590, May 1984, 8 Fig., 3 Tab, 26 Ref. National Science Foundation grant ATM-8114723.

Descriptors: *Catchment areas, *Storms, *Model studies, Poisson distribution, Mathematical equations, Tropical regions, Thunderstorms, Sudan, Precipitation.

The fraction of a catchment's area wetted by a rainstorm occurrence within the catchment is modeled by the sum of independent random cell clusters whose stationary centers are Poisson-distributed in space and whose areas are fractuals having identical (hyperbolic) pdfs. The cell clusters collected within the catchment are called catchment storms. They have specific areas and are assumed to be Poisson distributed in time. The independence, stationarity, and areal homogeneity assumptions associated with the cell clusters are met most closely by tropical air mass thunderstorms. The mean and variance of catchment average annual precipitation are derived in terms of the catchment area, the fractual dimension, the minimum cell cluster area, the maximum cell cluster area, and the two Poisson parameters. Station precipitation data from Sudan are used to evaluate the Poisson parameters. The average number of cell clusters per storm is large so that for large catchments, at least, the central limit theorem can be invoked and the entire distribution of storm area is approximated with these two moments. It should be possible to extend this work to eliminate some of the restrictive independence assumptions by introducing appropriate correlation structures and to include other storm types, both stationary and traveling. (Baker-IVI)
W84-05331

DRAINAGE DENSITY VARIABILITY AND DRAINAGE BASIN OUTPUTS

Australian National Univ., Canberra. Centre for Resource and Environmental Studies. D. G. Day.
Journal of Hydrology, Vol. 22, No. 1, p. 3-17, 1983. 6 Fig, 4 Tab, 33 Ref.

Descriptors: *Drainage basins, *Drainage density, *New South Wales, *Australia, Suspended sediments, Dissolved solids, Rainfall, Rainfall-runoff relationship, Catchment areas, Prediction.

Relationships between the drainage density of channelled flow and stream discharge, suspended sediment, and total dissolved solids were examined during rainfall events for two New England (NSW, Australia) catchments on granite and greywacke. Detailed observations were made on the two catchments. The drainage density of flow was measured as it fluctuated over rainfall events in a 16 month period. Such network changes were related to variability in stream discharge and dissolved solid concentrations for all storms, with higher correlations between these hydrologic variables for individual storms. For the catchments, drainage density can be used as a predictor of discharge. Data pooled for each catchment revealed that there are major differences in the runoff response which can be partly attributed to distinctive morphological differences between the catchments, specifically by contrasting densities of channel networks due to basic lithological and pedological differences. Rapid expansion and contraction of the flowing stream network exerts a dominant control on drainage basin outputs. (Baker-IVI)
W85-00183

EFFECT OF SPATIAL RAINFALL DISTRIBUTION OF SEWER FLOWS

Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie und Landwirtschaftlichen Wasserbau, W. Schilling.
Water Science and Technology, Vol. 16, No. 8/9, p. 177-188, 1984, 10 Fig., 8 Ref.

Descriptors: *Rainfall distribution, *Sewer hydraulics, *Rainfall-runoff relationships, Urban hydrology, Runoff forecasting, Runoff rates, Artificial storms.

When using a runoff model to generate input data for statistical computations, e.g., water balance, urbanization effects, design of dams, etc., the input data and the runoff

model should produce flow features which are correct on the average; the computer probability density function of peak, volume, and time-to-peak should not differ radically from the true ones. Errors in computing flows are caused by uncertainties about input data as well as uncertainties about appropriate models and model parameters. Errors of the input "rainfall", especially errors in spatial resolution, propagate by computation of sewer flows. Results of a case study about a sewer system with a catchment area of 2 sg km and ca. 1000 reaches between manholes show — that mean errors in rainfall event depths of about 20% occur even with five rain gages within or close to the catchment — that the errors by disregarding the spatial distribution are amplified rather than damped by the rainfall-runoff transformation and — that using spatially homogeneous rainfall input for flow computations cause systemic errors due to the wrong assumption of spatially homogeneous initial losses and due to dominating directions of storm movement. When using artificial storms, the spatial and temporal rainfall variability should be taken into account. (Collier-IVI)
W85-01689

EFFECTS OF A FLOODWATER-RETARDING STRUCTURE ON THE HYDROLOGY AND ECOLOGY OF TROUT CREEK IN SOUTHWESTERN WISCONSIN

Geological Survey, Madison, WI. Water Resources Div. Available from the National Technical Information Service, Springfield, VA 22161. Geological Survey Water-Resources Investigations 82-23, August 1982, 68 p. 35 Fig., 27 Tab, 67 Ref. (Wentz, D. A. and Graczyk, D. J., Editors).

Descriptors: *Stream discharge, *Floodwater, *Ecology, *Detention reservoirs, Streamflow, Flood peak, Channel morphology, Bed load, Sedimentation, Trap efficiency, Sediment transport, Sediment yield, Bankfull stage, Flood flow, Channel morphology, Hydraulic geometry, Trout, Aquatic insects, *Wisconsin, Trout Creek, Flood-water-retarding structure.

The primary effect of a floodwater-retarding structure (FRS) on the flow of Trout Creek, Wisconsin is attenuation of flood peaks. Reduction of flow peaks ranged from 58 to 91% during the study period, 1975 to 1979. An inverse relationship exists between sediment concentration and outflow from the FRS during floods. Most sediment stored in the flood pool during floods is released from the reservoir during subsequent reduced discharge. Sediment-trapping efficiency of the FRS was 7% during the 4-year study. The bankfull capacity of the channel was reduced from 154 cubic feet per second upstream from the FRS to 65 cubic feet per second downstream. Mean bankfull depth downstream from the FRS has adjusted to a value 45% less than upstream from the structure due to the sedimentation of materials transported from the FRS during reduced flows. The FRS was not found to have any significant adverse effect on the arthropod fauna or trout reproduction in Trout Creek from 1975 to 1979. During 1960-1979, winter floods seem to have had the greatest adverse effect on the survival of brown trout eggs and sac fry. (USGS)
W83-02985

EFFECTS OF CATCHMENT SIZE ON RUNOFF RELATIONSHIPS

New South Wales Univ., Kensington (Australia). School of Civil Engineering. D. H. Pilgrim, I. Cordery, and B. C. Baron.
Journal of Hydrology, Vol. 58, No. 3/4, p. 205-221, September, 1982, 3 Fig., 70 Ref.

Descriptors: *Catchment size, *Runoff, *Catchment basins, *Catchment areas, Drainage area, Unit hydrographs, Hydrographs, Rainfall-runoff relationships.

Concern has often been expressed that the hydrological processes and relationships on small catchments may not be representative of those on larger catchments, and that the relative importance of the various processes on the two types of catchments are different. The transfer of result to large catchments is of obvious practical importance. Factors that affect hydrological relationships between small and large catchments are reviewed, including the various processes and mechanisms by which runoff occurs, catchment characteristics such as land use, soils and geology, the variation of geomorphological characteristics with catchment size, small-scale nonhomogeneity of hydrological characteristics, and data errors. Hydrological responses of small catchments are likely to be different from and more variable than those of large catchments. While general relationships will exist between small and large catchments in a region, no simple or closely defined relations are likely. The transfer of many types of relationships from one region to another is also likely to be invalid. The findings of the review are illustrated by the results of an investigation of relationships between small and large catchments in eastern Australia involving annual rainfall-runoff relations, unit hydrograph parameters and storm loss rates. (Murphy-IVI)
W84-04847

EVALUATION OF THE HYDROLOGIC SOIL GROUPS AS USED IN THE SCS RUNOFF METHOD ON RANGELANDS

New Mexico State Univ., Las Cruces, Dept. of Animal and Range Sciences, M. K. Wood and W. H. Blackburn.
Water Resources Bulletin, Vol. 20, No. 3, p 379-389, June, 1984. 3 Fig, 4 Tab, 24 Ref.

Descriptors: *Surface runoff, *Soil types, *Rangeland, Vegetation, Infiltration, Cropland, Estimation, Hydrologic aspects.

The U. S. Soil Conservation Service has developed a method for estimating runoff for small watersheds when stream flow data are not available. The technique is based on a simplified infiltration model of runoff using various kinds of soil, land use, and empirical approximation. The model uses a runoff curve number of hydrologic soil cover com-

plex number. The equation overestimated observed runoff 67% of the time while estimating correctly 11% of the time and underestimating 22% of the values. This method explained 63% of the total plot-to-plot variation when all sites were pooled. Further testing revealed many problems with the hydrologic groups that are used to determine a curve number or hydrologic soil-cover complex number for the model. The equation actually worked better when the rangelands' vegetative condition become poorer and approached the bare conditions under which the technique was developed on croplands. When the vegetative condition became good or excellent by approaching the ecological climax, modification of the hydrologic soil groups was necessary. (Author's abstract)
W85-01384

GENERALIZED MODEL FOR STORMWATER RUNOFF HYDROGRAPHS

New Jersey Agricultural Experiment Station, New Brunswick. C. G. Uchrin and W. J. Weber, Jr.
Journal of Environmental Science and Health, Vol. A19, No. 1, p. 67-82, 1984. 7 Fig., 5 Tab, 4 Ref.

Descriptors: *Model studies, *Runoff, *Hydrographs, Storms, Rainfall-runoff relationships, Drainage basins, Rainfall distribution, Michigan. The most direct method for obtaining detailed stormwater runoff quantity and quality for specific drainage areas is by direct sampling and analysis, but it is often impossible to perform this for all inputs to a receiving water body. An empirical model is presented for generating runoff hydrographs for nationwide drainage basins as a function of the drainage area, population density, and rainfall excess distribution. A computer program was written incorporating the analysis. The model was applied to a study area in southeastern Michigan. A water quality model was constructed for the Huron River-Ford Lake-Belleville Lake system. Detailed sampling and analysis of each storm drain input source was unfeasible, so the runoff quantity model described was used in conjunction with a separate quality submodel to generate time variable pollutant loadings. (Baker-IVI)
W84-03954

GEOLOGY AND HYDROLOGY OF WETLANDS IN MASSACHUSETTS

Massachusetts Univ., Amherst, Dept. of Geology and Geography, W. S. Motts and A. L. O'Brien.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-154419, Price codes: A08 in paper copy, A01 in microfiche. Water Resources Research Center, Publication No. 123, Oct 1981, Univ of Mass., Amherst, p. 147, 9 Tab, 23 Fig., 67 Ref., 3 Append. B-012-MASS(11), B-023-MASS(18). 14-31-0001-3090 and 3596.

Descriptors: *Wetlands, Geology, Hydrology, Groundwater, Groundwater basins, Available water, *Groundwater potential, *Geohydrology, *Groundwater recharge, Aquifers, Surface-groundwater relations, *Groundwater movement, Water supply, Potential water supply, Water management, Well capacity, Water table wells, Artesian wells, Well yield, Artesian basins, Confined groundwater, *Massachusetts, Topographic-groundwater-wetland relationships, Amherst.

The report provides detailed data on three Massachusetts wetlands of varying character in diverse settings. The findings reveal a wide range of differences between wetlands in the extent to which they (1) modify the character of runoff from a basin, (2) influence the discharge/recharge relationship with their underlying aquifer, and (3) affect potential ground-water development. Wetlands cover 6.5% of the land area of Massachusetts. Two thirds of the state's wetlands are underlain by potential aquifers in stratified drift and lake bottom deposits. There is good probability of penetrating high saturated thicknesses of stratified-drift aquifers near wetlands. Artesian aquifers which commonly underlie lakebed-type wetlands are protected from man-induced contamination by the wetland, the clay cap, and the aquifer artesian pressure. This report proposes a classification to define the hydrologic response of wetlands using factors of hydrologic position, geologic type, and topographic position. Important geologic and hydrologic factors include character and thickness of surficial materials; bedrock type; hydrologic position and connection of wetland-related aquifers including permeability of their organic layer, their transmissivity, and their quality; groundwater outflow; and depth of standing water. Important topographic factors are wetland position in the drainage basin and both their relative and absolute size.
W83-01795

GEOMORPHIC APPROACH TO HYDROGRAPH SYNTHESIS, WITH POTENTIAL FOR APPLICATION TO UNGAGED WATERSHEDS

Louisiana State Univ., Baton Rouge, Dept. of Civil Engineering, V. P. Singh.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84 190115, Price codes: A06 in paper copy, A01 in micorfiche. Completion Report, June, 1983, 97 p. 27 Fig., 5 Tab, 32 Ref. OWRT project No. A-058-LA (1), Contract/Grant No. 14-34-0001-2120.

Descriptors: Hydrologic modeling, Stream flow synthesis, Upgaged basins, *Hydrographs, *Ungaged watersheds, Watersheds.

A conceptual approach, based on the work of Gupta, Waymire and Wang (1980), is developed for synthesis of the instantaneous unit hydrograph (IUH) by employing basin geomorphology. This IUH is then employed in convolution for synthesis of the direct runoff due to a rainfall event. Because the approach contains parameters which can be determined from geomorphology, it is potentially applicable to ungaged basins. A computer model, designated as GMHS, is developed using this approach for hydrograph synthesis. The model is verified on five small agricultural watersheds. The model results compare as well with observations in light of accuracy of the parameters and data.
W85-00069

HEAVY METALS IN ACID PRECIPITATION

Vermont Univ., Burlington, Dept. of Civil and Mechanical Engineering, D. R. Hemenway.

Available from the National Technical Information Service, Springfield, VA 22161 as PB83-175273, Price codes: A03 in paper copy, A01 in microfiche, Vermont Water Resources Research Center Completion Report, Univ. of Vermont, Burlington, December 1982, 30 p., 9 Fig., 7 Tab, 7 Ref. OWRT A-046-VT(1).

Descriptors: *Acid rain, *Acid precipitation, *Heavy metals, Aluminum, Lead, Cadmium, Vanadium *Vermont, Sampling, Data collections, Path of pollutants, *Pollutant identification, Water pollution sources.

Precipitation samples were collected sequentially on a sub-event basis. Specific contaminants in the segmented precipitation samples were measured for seven separate events. The concentration of Al, Cd, Pb, and V in the sub-samples of each event analyzed were determined along with sample pH. In the last three events, sulfate, nitrate, and chloride concentrations were also measured. The sub-samples for each event were filtered through a 0.1 μm membrane filter in an attempt to separate particulate matter from soluble species. Filtrate concentrations were as high as 243 μg/L, 53 μg/L, 91 μg/L and 8.3 μg/L for Al, V, Pb, and Cd, respectively, for the initial sub-sample. The only metal investigated associated with the suspended particulate was Al with concentration of up to 350 μg/L in the initial sub-samples. SO sub 4, NO sub 3, and Cl showed similar trends as pH during the course of an event. These concentrations were always high at the onset of precipitation, lowering as the event continued, but once again increasing, in differing degrees, in the final sub-samples. Results indicate that *chemical constituents in precipitation vary greatly with time*. Removal of certain contaminants may be greatly affected by scavenging efficiences of cloud and rain drops, and aerodynamic and chemical behavior of the aerosol rather than simple washout/dilution effects.
W83-02182

HYDROLOGY OF A SMALL IMPOUNDMENT AND WATERSHED IN CENTRAL OKLAHOMA

Agricultural Research Service, Chickasha, OK, R. Schoof.
Water Resources Bulletin, Vol. 19, No. 1, p. 15-21, February, 1983, 4 Fig., 6 Tab, 9 Ref.

Descriptors: *Watershed, Impoundments, *Hydrology, *Oklahoma, Runoff, Rainfall-runoff relationships, Evapotranspiration, Evaporation, Bitter Creek.

An analysis is presented of a site impoundment's water budget for five years of record, along with a study of the temporal and spatial distribution of water yield from the contributing watershed, measured from 1972 through 1980. On-site loss of water from the impoundment was only 17% of the inflow during three years when the annual precipitation averaged 26 inches and the annual inflow averaged 1.4 inches. Runoff from an eroded area with no farm ponds was about 70% greater per unit area than from a portion of watershed where 71% of the drainage area was controlled by farm ponds. Loss of top soil increased runoff significantly. Only 24% of the total runoff into the impoundment was base flow. The flow rate into the impoundment was less than 0.04 cfs 70% of the time, and the inflow rate exceeded 10 cfs only 1% of the time. SCS runoff curve numbers varied between 57 and 96 for the impoundment watershed, with an inverse relation between precipitation amount and curve number, apparently caused by partial area runoff from impervious and semi-impervious areas. A comparison of measured event runoff computer by the SCS curve numbers gave an r sq of only 0.44. However, the total computed surface runoff for eight years of record was less than 1% below the measured runoff, which indicated that the curve number method was a good tool for predicting long term runoff for the watershed. (Baker-FRC)
W84-00098

IMPACT OF DROUGHT ON QUALITY OF POTENTIAL WATER SUPPLY SOURCES IN THE SANGAMON RIVER BASIN

Southern Illinois Univ. at Carbondale. Dept. of Thermal and Environmental Engineering. C. B. Muchmore and B. Dziegielewski
Water Resources Bulletin, Vol. 10, No. 1, p. 37-46, February, 1983. 6 Fig., 5 Tab, 10 Ref.

Descriptors: *Water quality, *Drought, *Water supply, Water resources development, Ammonia, Manganese, Phenols, Specific conductance, Rivers, River basins, Streamflow, *Illinois, Sangamon River basin.

An analysis was made of streamflow and several water quality parameters in six Illinois rivers. The analysis showed that the 1976-77 drought produced significant streamflow deficiencies in the investigated streams of the 5,000 sq mile basin of the Sangamon River. Temporal and spatial variability of precipitation deficits within the basin had insignificant effects on the differentiation in timing of extremely low flows among various streams. The impact of drought on water quality was less uniform than the impact of streamflow. Overall, streamflow quality deteriorated, as a result of abnormally high concentrations of ammonia, maganese, and to a less extent, phenol and specific conductance. Significant decreases in concentrations of nitrites and nurates, coliform bacteria and total iron were noted. The approach to the analysis of water quality, using 12-month moving averages of monthly quality measurements, proved to be sensitive enough to clearly isolate the impact of drought from seasonal fluctuations in water quality. The analysis of instream flow and moving averages of nitrogen species concentrations revealed two distinct patterns of response to drought. They corresponded to streams characterized by an alternately high or low contribution of treated municipal effluent to low flow. The effects of land use patterns on water quality during the drought were hard to isolate due to the relative similarity of land uses for all investigated subbasins. However, the

more general thesis regarding the significant differences in response to drought among various streams seems to be substantiated in the case of impacts on water quality. It is suggested that streams which are considered unsuitable for municipal supply due to high levels of the quality indicators studied may be used as emergency sources during droughts. (Baker-FRC)
W84-00105

IMPROVEMENT OF FLOOD-FREQUENCY ESTIMATES FOR SELECTED SMALL WATERSHEDS IN EASTERN KANSAS USING A RAINFALL-RUNOFF MODEL

Geological Survey, Lawrence, KS, Water Resources Div.
R. W. Clement.
Available from OFSS, USGS Box 25425, Fed. Ctr. Denver, CO 80225. USGS Water-Resources Investigations Report 83-4110., 1983. 22 p., 2 Fig., 5 Tab, 21 Ref.

Descriptors: Surface water, *Floods, *Small watersheds, *Rainfall-runoff relationships, Precipitation, *Frequency analysis, Streamflow, Gaging stations, Model Studies, Annual floods, Antecedent moisture, Surface runoff, Precipitation excess, *Flood frequency, *Kansas, Rainfall-runoff models, Skewness.

The U.S. Geological Survey rainfall-runoff model was used to estimate model parameters for 13 small watersheds in eastern Kansas with drainage areas of less than 11 square miles. Model parameters and rainfall data from three long-term rainfall stations were used in the model to synthesize long-term records of simulated annual peak discharge, which were fitted to a Log-Pearson Type III distribution. Final estimates of T-year floods, which were computed by combining weighted estimates of the synthesized and observed T-floods, represent the most reliable estimates based on observed and long-term synthesized records of peak discharges. (USGS)
W85-01786

INSTREAM FLOW REQUIREMENTS OF NATIVE CALIFORNIA STREAM FISHES

California Univ., Davis. Dept. of Wildlife and Fisheries Biology. P. B. Moyle, D. M. Baltz, and N. J. Knight.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-196683, Price codes: A03 in paper copy, A01 in microfiche. California Water Resources Center Completion Report, Univ. of California, Davis, April 1983. 24 p., 12 Tab, 6 Ref. OWRT B-210-CAL(1).

Descriptors: *Instream flow, *Fish, Trout, Roach, Sculpin, Sucker, Perch, Velocity, Temperature, Water depth, Temperature effects, Streamflow, Streams, *California, *Fish habitats.

Summaries are presented for two year of microhabitat studies on ten species of California stream fishes: rainbow trout, brown trout, speckled dace, California roach, hardhead, Sacramento squawfish, Labontan redside, Sacramento sucker, Tahoe sucker, riffle sculpin, Paiute sculpin and tule perch. The measurements of velocity, depth and substrate associated with each species can be used to construct habitat use curves useful for small streams in the Sacramento Valley and in the Truckee drainage. It was found, however, that interactions among species can change microhabitat utilization and that each species has its own set of requirements which may differ somewhat between streams, reflecting both differences in the physical environment and differences in the composition of the fish community. It was also found that temperature has a significant effect on microhabitat utilization. As a consequence of temperature effects, species interactions and unpredictable fluctuations in flow, the relationship between habitat availability and actual use by the fishes is not a strong one. These results imply that if instream flow recommendations are based on the requirement so just one species (usually rainbow trout in California) the populations of other species may change in unpredictable ways. Instream flow recommendations made using "habitat preference curves" constructed from data collected outside the impact area may not give an accurate picture of the effects of the changed flow regime on rainbow trout or other species. (Snyder-California)
W83-02906

LABORATORY STUDIES OF THE EFFECTS OF THE CAPILLARY FRINGE ON STREAMFLOW GENERATION

Waterloo Univ, (Ontario). Dept. of Earth Sciences. A. S. Abdul and R. W. Gillham.
Water Resources Research, Vol. 20, No. 6, p. 691-698, June 1984. 110 Fig., 18 Ref.

Descriptors: *Capillary fringe, *Streamflow generation, Surface-groundwater relations, Runoff, Precipitation, Soil saturation, Water table, Hydraulic gradient, Seepage, Permeability coefficient, Slopes, Rainfall intensity.

This paper describes laboratory experiments that were conducted to investigate the groundwater surface water interactions during the process of streamflow generation. In particular, the experiments were designed to examine the role of the capillary fringe in the runoff processes and its influence on the groundwater response to precipitation. The experimental results clearly show that if the zone of tension saturation extends to, or near, ground surface, the application of a small amount of water can cause an immediate rise in the water table, and the magnitude of the rise is much greater than would be expected on the basis of normal specific yield values for sandy materials. Because of the sloping surface of the laboratory model the rising water table caused the rapid generation of hydraulic gradients directed towards the toe of the slope (the stream) resulting in the immediate generation of groundwater discharge to the stream. Two experiments using chloride as a tracer and having rainfall rates of 4.3 and 1.9 cm/h showed that the discharge of pre-event water to the stream

preceded event water and that at early times, pre-event water was the predominant component of streamflow. In addition, the results of the two tracer experiments show that the significance of pre-event water increased with decreasing rainfall rate and that for the 1.9 cm/h rainfall rate pre-event water was the main component of the stream hydrograph. The proportions of pre-event and event water in the streamflow after steady conditions were reached were determined largely by the extent of the seepage face. This in turn would be determined by the hydraulic conductivity of the medium, the surface slope, and the rainfall intensity. (Author's abstract)
W85-01342

LONG-TERM HYDROLOGIC EVENTS FROM SHORT-TERM RECORDS

N. Bethlahmy
Journal of Hydrology, Vol. 68, p. 141-148, 1984. 2 Fig., 1 Tab, 9 Ref.

Descriptors: *Hydrologic models, *Hydrologic data, *Flood forecasting, Mathematical models, Mathematical analysis, River forecasting, River flow, Flood flow, Low flow.

A new method based on ranks calculates the magnitude of hydrologic events associated with any desired probability. The system utilizes a transformation based on the median that yields positive values less than one. The method is substantiated through internal evidence. This method differs in a unique way from methods that define a distribution and then relate the probability of a variable to its deviation from the mean. Both the variable and its rank (its position in an ordered array) are transformed in an identical fashion. Because the time span N is brief, the hydrologist will normally be concerned with the magnitude of a variable at an extrapolated time T that is greater than sampling time N. As a result, n sub T for floods is always smaller than n sub N, and consequently q sub T will always exceed q sub N. If an extraordinarily large flood occurs during the base period N, then extrapolated flood will be even larger. The reverse would occur for low flows. (Murphy-IVI)
W84-03340

NATURE OF THE TILE-DRAIN OUTFALL HYDROGRAPH IN HEAVY CLAY SOILS

Birkbeck Coll., London (England). Dept. of Geography.
I. Reid and R. J. Parkinson
Journal of Hydrology, Vol. 72, No. 3/4, p. 289-305, June 1984. 6 Fig., 2 Tab, 28 Ref.

Descriptors: *Enfield Chase, *England, *Outfall, Tile drains, *Clays, *Hydrographs, Soil types, Clay soils, Subsurface drainage, Subsurface Drains, Drainage, Topography, Seepage, Flooding.

The outfall hydrographs of agricultural underdrainage installation in a heavy clay soil on Enfield Chase, England, were examined over four drainage seasons. Seasonal differences in drainage response to rainfall are attributed to antecedent soil conditions and these are controlled in part by the influence of topography upon downslope seepage. Bowl-shaped landforms are kept moister by convergent interflow streamlines and drainage follows the onset of rainfall most quickly in winter. Well-drained convex slopes, on the other hand, are subject to greater summer desiccation and deep cracks convey autumn rainwater, directly into the subsoil so that drainage response here is quicker at this time of year. Peak drainflow occurs at approximately 3.6 hours after the rainfall centroid in winter for both topographic situations but median values of peak discharge can be up to four times those of the non-winter drainage period during which adsorption of rainfall by the soil leads to a reduction in drainage outfall. The largest risk of flooding in river basins were underdrainage is widespread comes from complex storms. Secondary peaks in the drainage hydrograph not only arrive earlier by an average of 1.38 hours but are also shown to reach discharges more than three times those associated with simple storms having equivalent rainfalls. (Author's abstract)
W85-01614

NONLINEAR STOCHASTIC MODEL OF RAINFALL RUNOFF PROCESS

Georgia Inst. of Tech., Atlanta, GA, School of Civil Engineering, S. G. Rao and R. A. Rao.
Water Resources Research, Vol. 20, No. 2, p. 297-309, February, 1984. 7 Fig., 7 Tab, 18 Ref. OWRT project C-3277.

Descriptors: *Nonlinear stochastic models, *Rainfall-runoff relationships, Rainfall, Runoff, Forecasting, Rough River, Kentucky.

A nonlinear stochastic model is proposed to model the rainfall runoff process in which higher order derivatives of rainfall are used in addition to the magnitude of rainfall as inputs. The rainfall, runoff, and derivatives of rainfall are considered as stochastic. The model consists of several subsystems in parallel. The first subsystem utilizes the observed rainfall and runoff as input and output, respectively. The subsequent subsystems use higher order derivatives of rainfall as input and forecast error from the previous subsystems as output. The subsystems improve the performance of the overall model by using higher order derivatives of input. The error in forecasting the runoff is progressively reduced by each subsystem. The method of analysis and parameter estimation of each of the subsystems are the same except that different inputs and outputs are used to characterize the subsystems. The optimal output of each of the subsystems is computed by minimizing the corresponding mean square error, and the estimation procedure is based on the statistical theory of filters involving the marginal and joint probability density functions of rainfall, runoff, and rainfall derivative sequences. The model is tested using daily rainfall runoff data from the Rough River basin in Kentucky. Testing the residuals of the model for whiteness is emphasized in order to improve the prediction performance of the model. (Murphy-IVI)
W84-03826

PARAMETER ESTIMATION OF MULTIPLE INPUT-OUTPUT TIME SERIES MODELS: APPLICATION TO RAINFALL-RUNOFF PROCESSES

Princeton Univ., NJ. Dept. of Civil Engineering. D. M. Cooper and E. F. Wood.
Water Resources Research, Vol. 18, No. 5, p. 1352-1364, October, 1982. 6 Fig., 3 Tab, 22 Ref.

Descriptors: *Hydrologic models, *Time series analysis, *Streamflow forecasting, *Model studies, Rainfall-runoff relationships, Parametric hydrology, Runoff, River flow, Tributaries.

In time series modeling of hydrologic systems the model structure either is determined a priori from physical considerations or is identified statistically. This paper sets forth a maximum likelihood procedure for estimating the parameters of a class of statistical models (linear time-invariant state-space) once a suitable member of the class has been identified. Using the innovation form of the state-space model, the parameters of the transition, input weighting, gain and output, or measurement matrices are estimated as well as the innovation covariance matrix. Procedures for estimating process and measurement covariances in the state-space model, and the parameters of the equivalent multivariate autoregressive moving average with exogenous inputs (ARMAX) model are also developed. A convergent and asymptotically efficient online method of estimation is derived from the off-line algorithm. Four examples are presented: daily rainfall-runoff forecasting, four-site monthly stream-flow, seasonal model, and river flow input-output model with a tributary. (Author abstract)
W83-02278

PARAMETER IDENTIFICATION OF TIME-VARYING NOISY DIFFERENCE EQUATIONS FOR REAL-TIME URBAN RUNOFF FORECASTING

McMaster Univ., Hamilton (Ontario), Dept. of Civil Engineering and Engineering Mechanics, G. G. Patry and M. A. Marino.
Journal of Hydrology, Vol. 72, No. 1/2, p. 25-55, April, 1984. 14 Fig., 10 Tab, 43 Ref. CSRS project CA-D*-LAW-4254-H.

Descriptors: *Urban Runoff, *Runoff forecasting, *Model studies, Runoff, Montreal Island, Quebec, Rainfall, Sewer systems, Catchment areas.

Linear difference equation models, which constitute a particular subset of input-output models, offer an interesting alternative to the more complex conceptual runoff models. For real-time urban runoff forecasting, such models can be be very appropriate, because in addition to being parametrically parsimonious, they are computationally more efficient than the usual mechanistic models. Moreover, their use in recursive-adaptive mode can lead to good agreement between forecast and observed flows, particularly for short forecast lead times. Transfer function model parameters were identified under noisy input (rainfall) and output (flow) measurement conditions. Equation-error and output-error types of recursive parameter identification algorithms were compared for accuracy and convergence rate. The analysis is extended to the identification of time-varying parameters by including into the identification process, sets of rainfall-runoff events generated by distinct impulse response functions observed on the Curotte-Papineau catchment on the north shore of the Island of Montreal, Canada. Although no specific parameter identification method could be identified as being systematically better than the others, output-error algorithms have generally been observed to converge more rapidly than the equation-error algorithm, particularly in the first stage of the identification process. (Collier-IVI)
W85-01167

PRECIPITATION AND RUNOFF ON EIGHT NEW ENGLAND BASINS DURING EXTREME WET AND DRY PERIODS

Science and Education Administration, University Park, PA., Northeast Watershed Research Center, R. J. Deangelis, J. B. Urban W. J. Gburek, and M. A. Contino.
Hydrological Sciences Journal, Vol. 29, No. 1, 1984. 7 Fig., 4 Tab, 23 Ref.

Descriptors: *Precipitation, *Rainfall-runoff relationships, New England, Runoff, Seasonal variations, Watersheds, Evapotranspiration, Sleepers River Watershed, Vermont.

Extreme wet and dry 12 month periods occurred during the 20 years of hydrological data collections made at the Sleepers River Watershed (Vermont). Extrapolation of a nearby 87-year precipitation record to the basin was useful in determining the deviations of those extreme periods from normal. Seasonal water-input and runoff increased with elevation for both the wet and the dry period. For both water-input and runoff, the rate of increases was greater during the wet period. The slope of the water-input and runoff regression lines is related to the magnitude of the water-input. Variations in the measured flow at the eight sub-basins examined were due to the complex basin and climatological conditions typical of New England basins. However, the variations may be adequately described using elevation alone as the index. The fact that the increase in summer precipitation with elevation was significantly greater than the increase in runoff suggests that evapotranspiration increased with elevation. The greater magnitude of precipitation at higher elevations results in more potential and thus more actual evapotranspiration. (Baker-IVI)
W84-04067

PREDICTING DISCHARGE ON UNGAGED STREAMS FROM RAINFALL MEASUREMENTS IN SOUTHERN ARIZONA

Arizona Water Resources Research Center, Tucson, AZE. S. Simpson and D. C. Chery.
Available from the National Technical Information Ser-

vice, Springfield, VA 22161 as PB84-105352, Price codes: A04 in paper copy, A01 in microfiche. Completion Report, July 1983. 47 p., 25 Fig., 2 Tab, 17 Ref. OWRT A-077-ARIZ(2), 14-34-001-7005/7006.

Descriptors: *Parametric hydrology, *Hydrologic models, Computer models, * Streamflow forecasting, Runoff forecasting, *Arizona, Rainfall intensity, Model studies.

Recent developments in the numerical solution of the governing partial differential equations for overland and channel flow (represented by sets of intersecting planes) should make possible models which predict runoff from ungaged streams. However, these models (physically based models) are complex and require much computer time. Parametric models exist which have the advantage of being relatively simple, and once calibrated may be used efficiently and inexpensively. This study developed a procedure for calibrating a parametric model against physically based model utilizing base areas of one acre and one square mile, with the expectation that base areas can be combined to model real watersheds. Simulation experiments with the physically based model showed that, for the one-acre bases area, the dominant parameters relate to the slope and friction of the planes, whereas for the square-mile area, the dominant parameters relate to the channel properties. The simple model-fitting parameters were the cell storage ratio, K, for the one-acre area, and K plus a lag factor, L, for the square-mile area. These parameters decreased more or less exponentially with increasing rainfall intensity and with changes in the physical parameters that produced high peaks and fast runoff.
W83-04137

PRELIMINARY CALCULATIONS OF AVERAGE STORM DURATION AND SEASONAL PRECIPITATION RATES FOR THE NORTHEAST SECTOR OF THE UNITED STATES

Battelle Pacific Northwest Labs., Richland, WA.J. M. Thorp and B. C. Scott
Atmospheric Environment, Vol. 16, No. 7 p. 1763-1774, 1982. 3 Fig., 9 Tab, 6 Ref. DOE contract DE-AC06-76RLO-1830.

Descriptors: *Precipitation rate, *Storm duration, *Seasonal variations, Storms, Temporal distribution, Rainfall rates.

Regional and seasonal averages of storm duration and precipitation rates are needed as input variables in models aimed at describing precipitation processes relating to acid rain and other problems. Hourly precipitation data for 77 first order weather stations were used to calculate the summer and winter regional average storm duration and average precipitation rates over the northeastern United States. Average storm duration for summer (June-July-August), and winter (December-January-February) seasons considered periods of up to three dry hours in summer storms, and up to 6 dry hours in winter storms to be part of the same storm. Thus, each storm consisted of one or more precipitation periods. The average precipitation event rates for summer and winter storms were calculated. By considering storm durations on an hourly basis, the 3-h summer storm was found to contribute the greatest fraction to total summer precipitation. Similarly, the 26-h winter storm was found to contribute the greatest fraction to winter precipitation. The summer storms typically consisted of one rain event lasting about three hours with rain rates averaging about 2.5 mm/h. The 25-h winter storm averaged about 3 precipitation periods (or rain bands). Each period lasted about seven hours and had an average precipitation rate of 1.0 mm/h. (Author's abstract)
W85-00242

RAINFALL PATTERNS IN THE WESTERN UNITED STATES

Commonwealth Scientific and Industrial Research Organization, South Melbourne (Australia), Div. of Chemical Technology, R. G. Vines.
Journal of Geophysical Research, Vol. 87, No. C9, p. 7303-7311, August 1982. 12 Fig., 22 Ref., 1 Append.

Descriptors: *Rainfall, *Filter analysis, Sunspot cycle, Lunar cycle, Climatology, Time series analysis, Spectral analysis, Statistical methods.

Rainfall figures from World Weather Records, for towns west of the Mississippi in the United States, have been subjected to filter analysis. Time series comprising sets of annual rainfall data are analyzed in terms of the outputs of four filters. Filter IV reproduces what is essentially the moving-average rainfall over a long term. Filter III responds to any periodic fluctuations in precipitation in the range ca 13 to 30 years with high acceptance from 15 to 24 years. Filter II has corresponding response from ca 8 to 13 years with high acceptance from 9 to 12 years. Filter I responds to fluctuations from 6 to 8 years. The combined response of all four filters is nearly flat from about 6.5 years to infinity and all fluctuations with periods less than about 5.5 to 6 years are suppressed. The rainfall patterns obtained suggest substantial coherence of the data throughout much of the entire area. The results agree well with earlier work that reported a relationship between the incidence of drought, based on tree-ring data, in the western United States and the double (ca 22 year) sunspot cycle. However, an additional correlation with the (ca 18 year) lunar cycle is also apparent, particularly on the west coast. These findings have been verified by simple spectral analysis. Correlations using rainfall data alone might prove of use in future studies of climatic variability. (Collier-IVI)
W85-00513

RAINFALL-RUNOFF RELATIONSHIPS OF SOME CATCHMENTS WITH KARSTIC GEOMORPHOLOGY UNDER ARID TO SEMIARID CONDITIONS

Ministry of Agriculture, Reclamation and Land Development, Benghazi (Libya). Dept. of Water and Soil, M. R.

de Vera.
Journal of Hydrology, Vol. 68, p. 85-93, 1984. 3 Fig., 2 Tab, 10 Ref.

Descriptors: *Rainfall-runoff relationships, *Karst hydrology, Semiarid climates, Catchments, Arid climates, Mathematical equations, Rainfall intensity, Soil water. Review of available consultant reports on water resources studies in the northeastern zone of Libya shows that fourteen catchments have good data on rainfall and runoff for analysis, but only eight wadis have sufficient flood data of at least eleven events for linear regression analysis. The prevailing surface geology of practically all the catchments is marly limestone, which is conducive to karstification processes. Since wadi flow is a direct response to rainfall, proper consideration of the other factors that affect runoff would result in a better functional relationship for runoff estimation. Results of regression analysis of rainfall and runoff show that the correlation coefficient ranges from 0.219 to 0.89. This means that 4.8 to 80.3% of the variation in runoff can be accounted for by the regression equation. The qualitative effect of karstification is reflected in the highly variable ratio between rainfall and runoff. The runoff coefficient which is generally taken as the ratio of runoff to rainfall, should be used with caution for estimating historical or future runoff from catchments with karstic geomorphology, especially under arid to semi-arid conditions. A relationship expressing runoff as a function of rainfall intensity, rainfall duration, antecedent soil moisture, depth of unsaturated zone and degree of karstification should be investigated. (Baker-IVI)
W84-03338

RAPID NUMERICAL METHOD FOR HORIZONTAL FLUID FLOW IN UNSATURATED SOILS

Warren Spring Lab., Stevenage (England), J. M. Kirby.
Journal of Hydrology, Vol. 72, No. 3/4, p. 391-400, June, 1984. 3 Fig., 8 Ref.

Descriptors: *Unsaturated flow, *Aeration zone, *Horizontal flow, *Mathematical analysis, *Model studies, Infiltration, Conductivity, Vertical flow, Flow, Soil moisture.

Solutions for horizontal infiltration in unsaturated soils; scaling methods are often used which are quick and accurate, but are limited to this type of problem. A rapid numerical method for the horizontal flow of water was developed which can be used for solving problems other than infiltration. It is based on the approximation for conductivity k = k sub 0 exp (alpha psi). A simple expression for the velocity of flow was obtained, which produces accurate solutions to horizontal infiltration problems even with very large time and length steps, provided that the time step is below a certain limit which is related to the length step. An expression for estimating the maximum permissible time step was developed. The model has been used for both horizontal and vertical flow. The solutions are also economic (in terms of the time and necessary computer power). (Collier-IVI)
W85-01619.

REGIONAL MONTHLY RAINFALL-RUNOFF MODEL

National Technical Univ., Athens (Greece). Dept. of Civil Engineering, M. Mimikou and A. R. Rao.
Journal of Water Resources Planning and Management, Vol. 109, No. 1, p. 75-93, January, 1983. 17 Fig., 6 Tab, 8 Ref.

Descriptors: *Rainfall-runoff relationships, *Model studies, Flow, Nonlinear programming, Basins, River basins.

A simple regional model for basis with either linear or nonlinear monthly rainfall-runoff behavior is presented. The structure of the model depends on two key parameters: an order parameter and a memory parameter, which control the runoff behavior of the basin and the memory of the rainfall-runoff process, respectively. The order parameter, k, is a basin characteristic, whereas the memory parameter, n, is a characteristic of month, equal to k for months with delayed runoff and zero otherwise. For basins with linear monthly rainfall-runoff behavior, k is greater than one and is equal to the approximate order of nonlinearity of the monthly rainfall-runoff functional relations. Good relationships exist between the coefficients of the model and the monthly runoff coefficients of the basin, and between the latter and the rainfall reduced to the unit area of the basin. Under such circumstances the model is regionalized and may thus be used in other ungaged basins of the same region. The model preserves the historical monthly means and standard deviations of flow at the 90% confidence level. (Baker-IVI)
W84-04957

REVIEW OF RAINFALL DATA APPLICATION FOR DESIGN AND ANALYSIS

VIAK Consultants, Linkoeping (Sweden). V. Arnell, P. Harremoes, M. Jensen, N. B. Johansen, and J. Niemczynowicz.
Water Science and Technology, Vol. 16, No. 8/9, p. 1-45, 1984. 14 Fig., 4 Tab, 161 Ref.

Descriptors: *Rainfall, *Data processing, *Model studies, *Rainfall-runoff relationships, Design storms, Statistical analysis, Computer models, Computer studies, Storms, Floods, Prediction.

The introduction of computer technology has made it possible to handle quantities of data unheard just decades ago. Rain data is a good example of such masses of data that have become available for statistical analysis. The state of the art within the following areas was reviewed: 1) the statistical characterization of rainfall in time and space, 2) the development of synthetic design storms and, 3) the application of both synthetic design storms and historical storms to pipe design, flooding prediction, design of detention basins and calculation of the yearly or extreme pollu-

tional load on receiving waters from combined sewer overflows. The main conclusion, primarily related to item 3, is that more attention in this context should be put on statistical analysis of flooding and pollution. This analysis is best performed by applying historical rain records. Realistic flooding prediction is believed only to be possible with a fully dynamic flow model, whereas pollution may be studied by means of simpler models like the time area approach. The outstanding problem in statistical prediction is the distribution in space of the historical rains. (Collier-IVI)
W85-01677

RUNOFF CURVE NUMBERS FOR CONSERVATION TILLAGE

Agricultural Research Service, Beltsville, MD, Hydrology Lab.
W. J. Raws and H. H. Richardson, Journal of Soil and Water Conservation, Vol. 38, No. 6, p. 494-496, November/December, 1983. 1 Fig., 1 Tab, 19 Ref.

Descriptors: *Soil conservation, *Erosion control, Conservation tillage, Tillage, Conservation, Water conservation, Erosion, Runoff velocity, Runoff.

Conservation tillage effects on runoff vary. A new set of Soil Conservation Service runoff curve numbers reflect these effects, based on residue cover. The relative effectiveness of conservation tillage practices in controlling runoff depends on how much runoff velocity is reduced, how much surface storage is increased, how much conductivity and moisture storage is increased, and how much raindrop impact is reduced. The SCS procedure for predicting runoff uses total-event rainfall. The amount of residue left on the soil surface or the percentage of the soil surface covered by residue indicates the effectiveness of conservation tillage practices in reducing runoff. Conservation tillage causes a decline of 1 to 4 runoff curve numbers, translating into a reduction in runoff curve numbers, translating into a reduction in runoff from 9 to 16% associated with fallow land in good hydrologic conditions. The 9% reduction is associated with small grain, contoured and terraced with a good hydrologic condition. (Baker-IVI)
W84-03069

RUNOFF RESPONSE TO BASIN PARAMETERS IN SOUTHWESTERN NIGERIA

Ife Univ. (Nigeria), Dept. of Geography, O. O. Ogunkoya, J. O. Adejuwon, and L. K. Jeje. Journal of Hydrology, Vol. 72, No. 1/2, p. 67-84, April, 1984. 2 Fig., 6 Tab, 18 Ref.

Descriptors: *Nigeria, *Rainfall-runoff relationships, *Runoff rates, *Catchment basins, *Runoff response, Runoff coefficient, Saprolite, Soil water, Rainfall rate.

Runoff studies produce useful information on the water-yield capabilities of drainage basins with different physiographic and land-use attributes. They are of value in determining the proportion of rainfall that reaches the rivers as runoff, and in identifying those basin parameters that influence runoff response. Runoff studies are especially valuable where little information exists about the hydrology of drainage basins as in the case of southwestern Nigeria. The monthly, seasonal and annual runoff and runoff coefficients of fifteen third-order basins in a part of southwestern Nigeria were determined. Measured rainfall values generally exceeded 1400 mm except in four basins located in the north of the study area, which received between 927 and 965 mm. Rainfall was higher in the higher hilly part than in the rest of the study area. The runoff values appear to be generally low and vary widely among the basins. They also vary strongly over the hydrological year, reflecting the water-yielding capacity of the basin saprolite, rocks and soil-moisture status. This past appears to be very important at the peak of the rainy season. The annual runoff coefficients range from 1 to 40% of annual rainfall. There may be a correspondence between the temporal distribution of runoff from any basin and the pattern of rainfall distribution, but the runoff parameters considered are strongly influenced by the nature of the saprolite and rocks underlying the basins. (Collier-IVI)
W85-01169

SCS URBAN PEAK FLOW METHODS

Maryland Univ., College Park, MD, Dept. of Civil Engineering, R. H. McCuen, W. J. Rawls, and S. L. Wong. Journal of Hydraulic Engineering, Vol. 110, No. 3, p. 290-299, March, 1984. 2 Fig., 4 Tab, 8 Ref.

Descriptors: *Hydrologic models, *Flood peak, Flood basins, Flood recurrence interval, Flood forecasting, Flood frequency, Maximum probable floods, Flood hydrographs, Flood plain management, Urban watersheds, Urban hydrology, Urban areas.

The peak flow hydrologic methods of the U. S. Soil Conservation Service (SCS) (as contained in their Technical Release No. 55) are widely used for planning and design on small urban watersheds. The urbanization factors of the TR-55 methods (i.e., the lag factors for the graphical method and the peak factors for the chart method) were apparently not directly based on analyses of measured data and have not previously been systematically tested. Therefore, the objective of this study was to test the TR-55 methods and recalibrate the urbanization factors if the methods were found to be biased. A data base was compiled for 51 small urban watersheds under 4,000 acres (1,600 ha) in the United States. The annual maximum flood series were used to develop Log-Pearson Type III frequency curves, from which peak discharge rates were estimated for the following return periods: 2-yr, 5-yr, 10-yr, 25-yr, 50-yr, and 100-yr. The bias and accuracy of the SCS methods were evaluated using the Log-Pearson Type III estimate as the expected true value. The results indicate that no urbanization correction factors are needed for the graphical methods when time of concentration is determined using the velocity method. The adjustment factor for the hydraulic length modification of the channel only, and the hydraulic length

modification adjustment relationship is not a function of curve number. The curve for a curve number of 90 provides the most accurate prediction. (Murphy-IVI)
W84-03921

SENSITIVITY AND APPLICATION OF DIFFERENCE EQUATION MODELS TO REALTIME URBAN RUNOFF FORECASTING

McMaster Univ., Hamilton (Ontario), Dept of Civil Engineering and Engineering Mechanics, G. G. Patry and M. A. Marino.
Journal of Hydrology, Vol. 72, No. 1/2, p. 57-66, April, 1984. 5 Tab, 7 Ref, CSRS project CAA-D* LAW-4254-H.

Descriptors: *Differential equations, *Urban runoff, *Runoff forecasting, *Montreal, *Quebec, Rainfall, Sewer systems, Catchment areas, Error analysis.

Linear difference equation models for real-time urban runoff forecasting were applied to rainfall-runoff data collected on a 860 ha combined sewer catchment located in Montreal, Canada. Parameter identification of linear difference equation models for real-time urban runoff forecasting was reported previously (Patry, G. G. and Marino, M. A., 1984, J. Hydrology, Vol. 72, No. 1/2, p. 25-55.). The problems of parameter identification and forecast error analysis under the specification of erroneous model structures based on synthetically generated rainfall-runoff sequences were examined. Sensitivity analysis was conducted by using a variety of recursive parameter identification algorithms, including equation-error and output-error algorithms. Overestimation of the structural model polynomial order parameters na and/or nb (where na is the autoregressive level and nb is the exogeneous input level) is not as serious as underestimation of those parameters when measured in terms of the Root Mean Square Error (RMSE) in the simulated flows. The forecast models are applied to a combined sewer catchment for lead times ranging from 5 to 60 min. The Extended Estimation Method (EEM) algorithm was found to provide slightly better forecasts than either the Recursive Extended Least-Squares (RELS) or Recursive Ordinary Least-Squares (ROLS) algorithms for lead times of up to 30 min. (Collier-IVI)
W85-01168

SIMPLIFIED HYDROLOGICAL RAINFALL/RUNOFF MODEL

Ecole Polytechnique Federale de Lausanne (Switzerland). Inst. de Travaux Hydrauliques, W. H. Hager.
Journal of Hydrology, Vol. 74, No. 1/2, p. 151-170, October, 1984. 14 Fig., 1 Tab, 9 Ref, 2 Append.

Descriptors: *Rainfall-runoff relationships, *Hydrological models, Catchment area, Overland flow, Stream flow, Kinematic waves, Mathematical models, Rainfall intensity.

The rainfall-runoff process is investigated for relatively small catchment areas ($<$ 100 sq km) and for heavy rainfalls, It is assumed that: (1) the rainfall excess nearly equals the effective rainfall; and (2) the rainfall intensity function depends on time alone and is single-peaked. The catchment area is approximated by two rectangular planes of not necessarily equal width but with constant bottom slopes and constant roughness factors. A small stream runs where the two planes intersect each other. Both the overland and the stream flow are assumed to be fully turbulent; they are modelled using the Manning-Strickler formula. Kinematic wave theory serves as the mathematical model to compute the hydrographs at an arbitrary location in terms of the prescribed, basic parameters. The solutions are displayed graphically, which allows direct determination of the solution sought. Variations in the average bottom slope and the average friction coefficient are found to have little influence on the resulting hydrograph. Rough estimates of these parameters suffice to obtain fair results. The model is tested by comparing observations collected in western Switzerland with present predictions. Agreement between the computed and the observed hydrographs is fair, given the simplicity of the described hydrological model. A step-by-step procedure with examples illustrate the method in detail. (Author's abstract)
W85-03088

SIMULATED STREAMFLOW DATA FOR NORTH CAROLINA

North Carolina State Univ. at Raleigh, Dept. of Biological and Agricultural Engineering, E. H. Wiser.
UNC-WRRI Rpt. No. 170, December 1981. 41 p., 3 Fig., 6 Ref, 11 Append. OWRT A-093-NC(1), 14-34-0001-7070.

Descriptors: *Streamflow forecasting, Simulation analysis, Simulation, Streamflow, *Water data, Mean flow, Low flow, High flow, Watersheds, *North Carolina, Synthesis, Reservoir regulation.

A system was developed for simulation of streamflow data at any point in a region. The system is know as NCSSARR (North Carolina version of the Streamflow Synthesis and Reservoir Regulation model). NCSSARR is based on the Streamflow Synthesis and Reservoir Regulation (SSARR) Program developed at the North Pacific Division of the Corps of Engineers in Portland Oregon. Control programming minimizes input requirements to permit a planner with limited hydrologic or computer background to use the system. The system is interfaced with the data storage and retrieval system known as HISARS to provide convenient data access as well as routine processing of the simulated streamflow data. Simulated streamflow data have been obtained for most river basins in North Carolina. Parameters required for the simulation have been obtained by comparing the simulated data with observed data wherever available. After fitting, the simulated data have been compared with observed data with respect to several criteria, including mean flow, low flow, high flow and monthly distribution. The data are in reasonable agreement for most stream gages, implying that the simulated data may be used in lieu of observation wherever the latter are not available.
W84-00492

SIMULATION OF THE URBANIZATION EFFECT IN FLOW

Fundacao Centro Tecnologico de Minas Gerais (Brazil), J. C. Motta, Jr. and C. E. M. Tucci.
Hydrological Sciences Journal, Vol. 29, No. 2, p. 131-147, June, 1984. 9 Fig., 5 Tab, 11 Ref.

Descriptors: *Urban watersheds, *Urbanization, *Model studies, *Simulation, *Diluvio Creek, *Porto Alegre, *Brazil, Urban planning, Urban drainage, Urban hydrology, Flood hydrographs, Interception loss, Soil storage loss, Basin routing, Channel routing, Mathematical models, Rainfall-runoff relationships.

A consequence of urban development in a basin in the increase of peak discharge and surface flow which may cause flooding. Main channel design has to take into account future city development. A mathematical conceptual rainfall-runoff model was developed in order to simulate the urban Diluvio Creek basin at Porto Alegre (Brazil). The model has four algorithms: interception losses, soil storage loss, basin routing, and channel routing. Channel flow is routed by the model through a kinematic wave formulation with the lateral flow calculated by the earlier IPH II version of the model. Based on the Urban Development Master Plan, some of the model parameters were modified and evaluated, and a preliminary assessment of the effect of urbanization on flow hydrographs was made. (Collier-IVI)
W85-01134

SPACE-TIME QUANTIFICATION OF RAINFALL INPUTS FOR HYDROLOGICAL TRANSPORT MODELS

Agricultural Research Service, Chickasha, OK, Southern Great Plains Watershed Research Center, A. D. Nicks
Journal of Hydrology, Vol. 59, No. 3-4, p. 249-260, November, 1982. 3 Fig., 4 Tab, 18 Ref.

Descriptors: *Hydrologic models, *Rainfall, Spatial distribution, Temporal distribution, Model studies, Transport.

Time and spatial rainfall input to hydrological models are discussed from the standpoint of available data sources, microscale and mesoscale networks and the type of models available. Using rainfall records from a dense network of recording rain gages methods of distribution rainfall from point amounts to distributed runoff model area elements are tested. Density of the rain gage network spacing vs. size of the distributive model elements are tested on basins ranging in size from 67 to 2926 sq km. Models should be developed that will account for time increment effects on runoff generation. One model tested showed an increase of 24% in predicted runoff when breakpoint rainfall was input instead of the original hourly input data. Spatial distribution of rainfall described by experimental watershed networks is probably adequate for most distributive type models. For the wide spaced climatological networks, the cost of using available distribution methods would be prohibitive for short time input with a small grid interval on a large area. More research is needed to set guidelines on the size of grid element vs. network gage density. (Baker-IVI)
W84-05340

SPATIAL VARIABILITY OF RUNOFF

Agricultural Research Service, Columbia, MO, North Central Watershed Research Center, A. T. Hjelmfelt, Jr. and R. E. Burwell.
Journal of Irrigation and Drainage Engineering, Vol. 110, No. 1, p. 46-54, March, 1984. 6 Fig., 2 Tab, 10 Ref.

Descriptors: *Runoff, *Spatial variability, *Small watersheds, Simulation, Water retention, Model studies, Storm runoff, Variability, Confidence limits.

During the spring and summer of 1981, 40 adjacent runoff-erosion plots (each 27.4 x 3.2m) were maintained in a fallow condition. Twenty-six rainfall events occurred that produced runoff during this period. The array of plots simulate an intensively sampled watershed of field size, so the results are analyzed to describe spatial variation of runoff and water retention. The coefficient of variation for individual events in which all plots exhibited runoff ranged from 0.65-0.07. Individual plots did not react consistently throughout the series of storms, but were seen to shift between producing more and less than the average volume of runoff. In the usual descriptions applied by current mathematical models of small watersheds, each plot was identical, so these results contribute to defining confidence limits that can be applied to model results, i.e., if a mathematical model were constructed that predicted the 40-plot mean for each event, and that model were compared with the observed values for any one plot, there would be differences between predicted and observed results. This study helps to establish the significance of that difference. (Moore-IVI)
W84-04093

STAGED APPROACH TO APPLICATION OF RAINFALL DATA TO URBAN RUNOFF CALCULATIONS

Technical Univ. of Denmark, Lyngby, Dept. of Sanitary Engineering, P. Harremoes, M. Jensen, and N. B. Johansen.
Water Science and Technology, Vol. 16, No. 8/9, p. 237-250, 1984. 6 Fig., 15 Ref.

Descriptors: *Urban runoff, *Urban hydrology, *Rainfall distribution, *Denmark, Intensity-duration-frequency curves, Model studies, Mathematical studies, Computer programs.

A coherent staged approach to application of rain data from long rain records to urban storm drainage has been developed in Denmark and is in the process of being implemented at the central computer center of the Danish

municipalities. The approach is based on the principal that a spectrum of methods should be made available to the practitioner, from the simplest calculation by hand to the most advanced application of historical rain events as input to the most complicated computer programs. The simplest method is the traditional use of intensity-duration-frequency curves and the rational method. This is equivalent to running a time-area method with a straight time-area curve through all the rain events of a historical rain series. The form factor is used to multiply the flow obtained from the rational method. The use of the rational method with a form factor between 1.0-1.4 is recommended, depending on an estimated shape of the time-area curve. From that basis there are stages of increasing sophistication; the utopian approach is to run all recorded rain events of a rain series through the best available computer programs with very accurate data for the catchment under consideration. The best available programs involve a continuous hydrological simulation model and a model based on the dynamic wave theory for pipe flow. The choice of method depends on the level of ambition and the accuracy of the basic input data for the catchment in question. (Collier-IVI)
W85-01694

STATISTICAL SUMMARIES OF NEW JERSEY STREAMFLOW RECORDS

S. L. Lakowski, Water Resources Circular 23, New Jersey Dept. of Environmental Protection, Trenton, NJ, 1970. 264 p., 3 Fig., 21 Ref., 1 Append.

Descriptors: *Daily hydrographs, *Data acquisition, *Hydrologic data collections, *Statistical analysis, *Stream discharge, *Stream gages, *Onsite data collection, Gages, Flow, Statistical methods, Statistics, Parametric hydrology, Data collections, *New Jersey.

The records for 79 of approximately 100 stream-gaging stations presently or previously operated in New Jersey, plus records for three stations in Pennsylvania, and one in New York are presented in summarized form. In addition to including a greater number of stations in this report, more years of record and more tables are listed for each station than in the 1958 report. A description of the station, three arrangements of data summarizing the daily flow records, and one table listing statistics of the monthly mean flows are provided. No data representing instantaneous extreme flows are given. Plotting positions for the three types of curves describing the characteristics of daily discharge are listed for each station. Statistical parameters are also presented so that alternate curves may be drawn. All stations included in this report have five or more years of record. The data presented are based on observed flow past the gaging station. Since any streamflow record is a sample in time, the data derived from these records can provide only a guide to expected future flows. For this reason the flow records are analyzed by statistical techniques, and the magnitude of sampling errors should be recognized. These analyzed data will be useful to a large number of municipal, state and federal agencies; industries; utilities; engineers; and hydrologists concerned with the availability, conservation, control, and use of surface waters. The tabulated data and curves can be used to select sites for water supplies and to determine flood or drought storage requirements. The statistical values presented herein can be used in computer programs. (Garrison-Omniplan)
W84-00800

STOCHASTIC SIMULATION OF EVAPORATION DATA FOR AUSTRALIA

Melbourne Univ., Parkville (Australia), Agricultural Engineering Section, R. Srikanthan and T. A. McMahon.
Nordic Hydrology, Vol. 14, No. 4, p. 207-228, 1983. 2 Fig., 10 Tab, 16 Ref.

Descriptors: *Stochastic process, *Evaporation, *Model studies, *Australia, Rainfall, Simulation, Computer models.

One major use of evaporation data in conjunction with rainfall data is in computer simulation modelling of rainfall/runoff processes. Stochastic models are developed to simulate annual, monthly and daily evaporation data for Australia. For annual and monthly synthesis, the evaporation values are generated independently and dependently of rainfall. Generation of daily evaporation is based on the knowledge of occurrence of daily rainfall. Data from nine Australian stations are used to illustrate applications of the models. Evaporation data only can be generated using a first order Markov model and a two-tier model. With an adequate length of historical data, the method of fragments can be used to generate monthly evaporation. If evaporation data are required along with rainfall, both should be generated simultaneously so that the observed cross correlations are preserved. For annual data, a multisite type model is satisfactory. For monthly data where an adequate length of evaporation data is available, a model is provided which may be used to generate monthly evaporation and rainfall simultaneously. A second model is also presented which can be used to generate monthly evaporation from previously generated monthly rainfall. Finally, a first order Markov model dependent on the type of day was found to perform satisfactorily in generating daily evaporation data. (Baker-IVI)
W85-01236

STORMFLOW GENERATION IN A HEADWATER BASIN IN THE TAMA HILLS (IN JAPANESE)

Tsukuba Univ. (Japan), Inst. of Geoscience, M. Yasuhara, S. Takayama, and Y. Suzuki.
Japanese Journal of Limnology, Vol. 45, No. 1, p. 44-50, January 1984. 11 Fig., 12 Ref.

Descriptors: *Headwaters, *Storm runoff, *Tama Hills, *Japan, Rainstorms, Storm seepage, Subsurface water, A-horizon.

Research was conducted in a small headwater basin of 0.56

ha in size in the Tama Hills to clarify the mechanism of stormflow generation. Observations were made in the field during and after a 130.5 mm rainstorm occurred on Oct. 78, 1979. At each stage of the rainstorm the relationship between subsurface water behavior and stormflow generation was established by using 56 observation wells and 40 tensionmeters. Three contributors to stormflow generation were recognized: subsurface stormflow in the A-horizon, saturation overland flow, and flow from the shallow groundwater body. A quantitative analysis of the observed results revealed that the subsurface stormflow in the A-horizon was the most important contributor to stormflow generation in the experimental basin. In regions such as Japan, where rainstorms with a total rainfall of more than 100 mm often occur, much more attention should be concentrated on the role of the A-horizon in stormflow generation. (Baker-IVI)
W85-00190

STUDY OF SPACE VARIATIONS OF PRECIPITATION BY FACTOR ANALYSIS

Ecole Polytechnique, Montreal (Quebec), P. Beaudoin and J. Rousselle.
Journal of Hydrology, Vol. 59, No. 1-2, p. 123-138, October, 1982. 4 Fig., 4 Tab, 11 Ref., Ministere de l'Education du Quebec grant CRP-356-75.

Descriptors: *Precipitation, *Spatial distribution, *Factor analysis, *Montreal, *Quebec, Rainfall distribution, Seasonal variation.

Spatial variations in daily precipitation in the region of Montreal, quebec are examined through factor analysis of the inter-station correlation coefficients matrices. A sample of 25 years of daily precipitation data, which were available at 19 stations, was selected for the study. Independent analyses are made for each of the four seasons of the year. Factor patterns are obtained from oblique rotation of the first six principal components of the correlation matrices. Areas in which meteorological stations have a similar factor pattern are delimited. The clustering was not very different from season to season, although the variance explained by six factors was less in summer than in the other seasons, due to the higher variability of precipitation in summer. In the Montreal region, clusters were generally formed in the Laurentians, at the foot of the Appalachian Mountains, at Montreal Island and the adjacent south shore area, and in the plains north of Montreal Island; also two clusters were formed in the south of the region which were different in shape from season to season. The whole area could be divided into only five areas having relatively homogeneous climatological characteristics. Extreme values in the data have a strong weight in the computation of the factor patterns. However, in the Montreal region, the regionalization obtained from analyses of samples containing only small values of precipitation has the same general shape as the one obtained from samples of large values. Factor analysis represents an objective way of condensing information in a meteorological network, but it must be subjected to the investigator's judgement. (Moore-IVI)
W84-05130

STUDY ON MEASURED CURVE NUMBER AND PREDICTION OF RUNOFF FROM FORESTED WATERSHED

Chong, S. K. Mar 1982. NTIS, PC A12/MF A01. From 2. CEURC annual program of coal review conference; Carbondale, IL, USA (22 Apr 1981).

The Soil Conservation Service curve number method is a well accepted technique in applied hydrology for determining runoff from rainfall. The curve number (CN) of an area in a watershed indicates its runoff potential. The accuracy of using the curve number method for predicting runoff depends upon the accuracy of selecting a CN value. In this study, the measured CN values from paired forested watersheds were excerpted for studying. A simple method was then developed for predicting the CN values. In the developed method the effect of seasonal fluctuation and the size of the storm was considered. The calculated CN values are assessed by their use in predicting runoff and are subsequently compared with the measured values. For surface mining permit applications, the Office of Surface Mining recommends that the permit applicant monitor the proposed mine basin for a minimum period of six months. Within the six month period, it is hoped that at least three to four pairs of good rainfall-runoff data can be collected. Using this minimum hydrologic information, a rough mean R value can be calculated. It is assumed that the calculated mean R value will reflect all the combined physical characteristics of the watershed. Following the method suggested in this study, the CN value as well as runoff for various rainfall storms can be predicted. The potential maximum retention, S, in the curve number equation is not measurable. Since the runoff coefficient R is measurable, using the measured value to predict runoff should produce more reliable results.

SUBSURFACE STORMFLOW: AN ANALYSIS OF RESPONSE TIMES

Virginia Univ., Charlottesville, VA, Dept. of Environmental Sciences, K. Beven.
Hydrological Sciences Journal, Vol. 27, No. 4, p. 505-521, December, 1982. 5 Fig., 4 Tab, 35 Ref.

Descriptors: *Storm seepage, *Slopes, Permeability coefficient, Saturated flow, Unsaturated flow, Response time, Kinematic wave theory, Mathematical equations, Model studies, Soil moisture.

On hillslopes where the soils are sufficiently permeable to make the occurrence of surface flow extremely unlikely, hillslope response will be dominated by subsurface stormflows involving both saturated and unsaturated flows. A simple theory for predicting the response times of unsaturated and saturated flows on hillslopes, based on kinematic wave equations, is presented. The sensitivity of unsaturated zone lag and time of concentration of the saturated zone to hillslope and soil parameters, antecedent moisture and input rates is examined. For many hillslopes subsurface flows will be too highly delayed to be considered

as a part of the stormflow response. Only where effective hydraulic conductivities are very high, the soil is wet and the water table or an impeding layer is close to the ground surface can rapid responses be expected. Even then, the effective slope length contributing to stormflow may be small. Under these conditions a kinematic model may be an appropriate one for modelling the fast subsurface response at the hillslope or catchment scale. (Moore-IVI)
W85-00695

USE OF RAINFALL-SIMULATOR DATA IN PRECIPITATION-RUNOFF MODELING STUDIES

Geological Survey, Denver, CO, Water Resources Div., G. C. Lusby and R. W. Lichty.
Available from the OFSS, USGS, Box 25425, Fed. Ctr., Denver, CO 80225. USGS Water-Resources Investigations Report 83-4159, 1983. 59 p., 36 Fig., 10 Tab, 12 Ref.

Descriptors: *Rainfall simulators, *Hydrologic models, *Runoff plot, *Overland flow, *Small watersheds, Infiltration rate, Experimental basins, *Colorado, Elbert County, Willow Gulch drainage basin. Results of a study using a rainfall simulator to define infiltration parameters for use in watershed modeling are presented. A total of 23 rainfall simulation runs were made on five small plots representing four representative soil-vegetation types of the study watershed in eastern Colorado. Data for three observed rainfall-runoff events were recorded by gages on four of the plots. Data from all events were used to develop best-fit parameters of the Green and Ampt infiltration equation. The hydraulic conductivity of the transmission zone, KSAT, grossly controlled the goodness of fit of all modeling attempts. Results of fitting KSAT to reproduce runoff from rainfall simulator runs and results of fitting KSAT to reproduce runoff from observed rainfall-runoff events are inconsistent. Variations in results from site to site and at different times of the year were observed. (USGS)
W85-00837

VARIATIONS IN MONTHLY PRECIPITATION OVER NORTH CAROLINA

North Carolina State Univ. at Raleigh, NC, B. K. Eder, J. M. Davis, and P. J. Robinson.
Water Resources Research Institute Report No. 185, January 1983, 46 p., 16 Fig., 1 Tab, 3 Append.

Descriptors: *Precipitation, *Local precipitation, *Precipitation rate, *Precipitation intensity, Atmospheric precipitation, Rain gages, Rainfall, Snow, Probable maximum precipitation, Statistical analysis, Histograms, Computers, Rainfall distribution.

In 1973, the WRRI of the University of North Carolina published a technical report entitled "Precipitation Variability Over North Carolina" by Saucier, Weber, and Bayne. This revised version of that report is intended to update precipitation maps to reflect the 1951-1980 normal period, and to be in a form useful to the general public and to technicians. The spatial and temporal variability of precipitation over North Carolina is examined through a statistical analysis of monthly normal precipitation data. Tables and maps derived from these data provide monthly precipitation means and standard deviations for 85 locations. The precipitation distribution is partially controlled by the geographic position of the state relative to the global atmospheric circulation system. Superimposed on this system are physiographic controls imposed by the Appalachian Mountains in the western part of the state and the Atlantic ocean to the east. The resulting precipitation patterns are quite complex. The annual precipitation has a summer maximum and a winter minimum. Alternating rainy and fair weather caused by atmospheric circulation causes precipitation that is derived mainly from cyclonic storms, which also create major elements of variability and unpredictability. Spring and autumn minima in rainfall are greatly affected by global atmospheric circulation which shift northward and southward in an annual cycle. Resulting precipitation peaks annually occur in February-March and July-August; minima generally occur in May-June and September-October. (Garrison-Omniplan)
W83-03992

BOX-JENKINS TRANSFER FUNCTION MODELS APPLIED TO SUSPENDED SEDIMENT CONCENTRATION-DISCHARGE RELATIONSHIPS IN A PROGLACIAL STREAM

Southhampton Univ. (England). Dept. of Geography, A. M. Gurnell and C. R. Fenn.
Arctic and Alpine Research, Vol. 16, No. 1, p. 93-106, February, 1984. 7 Fig., 5 Tab, 24 Ref.

Descriptors: *Suspended sediment, *Model studies, Glacial streams, *de Tsidjiore Nouve, *Switzerland, Linear regression analysis, Glacial sediments, Sediment load.

Suspended sediment rating curves have provided a simple method for the interpolation and extrapolation of suspended sediment concentration and load in proglacial streams. The usefulness of suspended sediment rating curves is explored using observations of suspended sediment concentration and discharge from the proglacial stream of the glacier de Tsidjiore Nouve, Valais, Switzerland. A logarithmic transformation of both suspended sediment concentration and discharge was suitable for estimating suspended sediment rating curves by linear regression analysis, but in spite of lagging, differencing, and weighting the variables, a consistently good method of predicting suspended sediment concentration from discharge was not found. A major problem was serial autocorrelation in the residuals from the sediment rating curves, and so a method placing central attention on the autocorrelation in the data series was adopted. A transfer function between the discharge and suspended sediment series was estimated. The transfer function gave by far the best forecasts of suspended sediment concentration of all the models investigated, even when it was applied to a different ablation season from that for which it was estimated. In addition, the transfer function and associated univariate time series models also provided information about the character of the suspended sediment and discharge series, which could be used to interpret the hydrology of the proglacial zone and the lower part of the glacier de Tsidjiore Nouve. The findings indicate that transfer functions are so superior to ordinary rating curves that they should be used whenever possible to predict suspended sediment load in proglacial streams. In the absence of a sufficiently good data base, the ordinary rating curve seems to be the second best approach of the methods investigated, but the resulting load estimates are likely to be highly erroneous. (Baker-IVI)
W85-00112

CALCULATION OF THE DEPOSITION OF RIVER SEDIMENTS ON THE NEARSHORE ZONE AND EVALUATION OF THE STABILITY OF THE SUBMARINE FAN

Gruzinskii Nauchno-Issledovatel-skii Inst. Gidroteknikii Melioratsii, Tiflis (USSR), V. V. Sakvarelidze and S. S. Pirumov.
Water Resources (English Translation), Vol. 9, No. 1, p. 76-82, January/February, 1982. 11 Ref., Translated from Vodnye Resursy, No. 1, p. 120-127, January/February, 1982.

Descriptors: *Sediments, *Rivers, *Sediment transport, Deltas, River sediments, Sedimentation, Currents, Waves, Fans.

A quantitative study was made of the processes of deposition of river sediments on the nearshore zone and formation of the depositional body. The problems of the deposition of river sediments on the nearshore zone were considered using the following two hypotheses when calculating the range of deposition of sediments: the sediments begin to be deposited from that site where the standard deviations of the vertical velocity fluctuation are less than the settling velocity of the sediments, and the longitudinal velocities of the water and sediment particles coincide. It was shown that the first hypothesis was valid only in those cases when the spreading jet did not lose contact with the bottom. In cases of spreading jet with detachment from the shore slope, particularly in the presence of a halocline, all beach-forming sediments regardless of the degree of turbulence of the spreading jet were deposited starting from the site of detachment. The second hypothesis was acceptable for all fine sediments with a diameter less than 4 mm. It was concluded that it is possible and expedient to reduce the volume of river sediments being transported to great depths of the nearshore zone by using a previously proposed sediment-retaining structure. This structure is intended for those rivers at the mouth of which there is no pronounced bar, or the bar is so then that it is eroded by the current in an average flood and the river jet transports a large part of the sediments to the stepoff or to the canyon. (Baker-FRC)
W83-02251

DAILY WATER AND SEDIMENT DISCHARGES FROM SELECTED RIVERS OF THE EASTERN UNITED STATES: A TIME-SERIES MODELING APPROACH

Geological Survey, Lakewood, CO. Water Resources Div, M. J. Fitzgerald and M. R. Karlinger.
Available from the Distr. Br., USGS, 604 S. Pickett St., Alex, VA 22304. USGS Water Supply Paper 2216, 1983. 24 p., 14 Fig., 7 Tab, 24 Ref.

Descriptors: *Model studies, Statistical models, *Hydrologic data, *Spectral analysis, Time-series modeling, *Sediment discharges, *Atlantic drainage.

Spectral and time-domain techniques were applied to daily water and sediment-discharge records from selected rivers of the eastern United States. Time-series models are constructed for analysis of the runoff-sediment yield system.

Logarithmic transformation and first-order differencing of the data sets produced second-order, stationary time series and removed seasonal trends. Cyclic models accounted for less than 42 percent of the variance in the water series and 31 percent in the sediment series. Spectral results indicate frequently occurring storm runoff can account for as much as 50 percent of the variation in sediment discharge. Coherence and phase spectra indicate that a linear representation is reasonable for the water-sediment system. Transfer-function models that incorporated water discharge as input prove superior to univariate techniques in modeling and prediction of sediment yields. The random component that includes errors in measurement and model hypothesis indicates no serial correlation. The unit step-response function calculated from impulse-response weights, can serve as an index of sediment production within or between drainage basins. (USGS)
W85-01823

DISTRIBUTION FUNCTION APPROACH TO MODELING BASIN SEDIMENT YIELD

Institute of Hydrology, Wallingford (England), R. J. Moore and R T. Clarke.
Journal of Hydrology, Vol. 65, No. 1-3, p 239-257, August, 1983. 8 Fig., 21 Ref.

Descriptors: *Sediment transport, *Model studies, *Sediment yield, Mathematical studies, Hydrographs, Erosion, Storm runoff.

The distribution function theory provides both a plausible description of sediment removal and translation as supply- and transport-limited processes, and a model structure suitable for automatic parameter optimization by grandient-based procedures. The exhaustion of sediment supplies during a storm event and the increasing availability of sediment as the inter-storm period lengthens are able to be represented by the mathematical description of accumulation of sediment and its removal by direct runoff. A linear convolution integral operation is used to accomplish translation of water and sediment to the basin outlet. An inverse Gaussian probability density function is proposed as a suitable two-parameter form for the instantaneous unit hydrograph. The relation of this distribution to the convection-diffusion equation, and its extension to represent settling out of sediment from suspension, are discussed. An extension of the distribution function model to incorporate a drainage (or baseflow) component is introduced as one means of representing hydrographs with protracted recessions. (Baker-IVI)
W84-02448

EFFECT OF RAINDROP IMPACT AND SLOPE LENGTH ON SEDIMENT CONCENTRATION OF RUNOFF

Purdue Univ., Lafayette, IN. Dept. of Agronomy, J. V. Mannering and W. C. Moldenhauer. Proceedings of the Indiana Academy of Sciences, Vol. 92, p. 463-467, 1982. 2 Tab, 8 Ref.

Descriptors: *Rainfall-runoff relationships, *Erosion, *Sediment transport, Rainfall intensity, Rainfall impact, Simulated rainfall, Black Creek Watershed, Indiana, Erosion control.

The effect of raindrop impact and surface runoff in detaching and transporting soil material was determined. This is important in order to develop land treatment measures that will effectively reduce sediment yields from agricultural watersheds. The study yields from agricultural watersheds. The study was made at the EPA-supported Black Creek Watershed Sediment Study located in Allen County, Indiana. The results of simulated rainfall and inflow studies on four soils (Haskins loam, Nappanee clay loam, Hoytville silty clay, and Moreley clay loam) show rainfall energy to be the major factor affecting sediment concentration of runoff ranged from 7 to 12 times that of inflow-induced runoff for all the soils. In the study, doubling or tripling the selected inflow to simulate increased slope length had little influence on sediment concentration. However, slope steepness did influence sediment concentration. On the test site having a 5.1% slope, sediment concentrations approximately three times those from the other three nearly level test sites occurred whether runoff was rainfall-induced, inflow induced, or a combination of both. These results demonstrate again the necessity of protecting the soil surface from raindrop impact in order to effectively reduce sediment concentrations of runoff which will, in turn, maintain soil productivity and enhance water quality. (Baker-IVI)
W84-05311

EFFECTS OF SLOPE LENGTH AND STEEPNESS ON SOIL EROSION FROM RANGELANDS

Washington State Univ., Pullman, WA, D. K. McCool. In: Proceedings of the Workshop on Estimating Erosion and Sediment Yield on Rangelands, Tucson, Arizona, March 7-9, 1981, Agricultural Reviews and Manuals ARM-W-26, June 1982, p. 73-95, 1 Tab, 34 Ref.

Descriptors: *Slopes, *Rangeland, *Soil erosion, *Rainfall rate, *Runoff, Mathematical models, Rill erosion, Rainfall simulators.

Data on the effect of slope length and steepness on soil loss from rangelands are virtually nonexistent. If accurate predictions of soil loss from rangelands are needed for range resource maintenance or water quality purposes, a program of data collection will be needed. The most rapid means of collecting this data will be with rainfall simulators larger than those previously used. In the interim, it is suggested that rangelands be classified as Category I (no observed or expected rill erosion under large rates and volumes of rainfall and runoff). Category II (moderate rainfall and runoff rate and moderate rilling observed or expected), and Category III (rill erosion expected from high rainfall and runoff rates). Equations were developed for predicting the influence of slope length and steepness on erosion. Because there is little data to support the relationships in these equa-

tions, and because of the wide range of values for slope steepness factor at slopes above 20% calculated from them, the equations are offered for field use on a trial basis and to elicit response from resource management personnel and researchers. (Moore-SRC)
W83-00099

EROSION FROM SIMULATED RAINFALL IN MOUNTAIN RANGELAND IN UTAH

Utah State Univ., Logan, UT, Dept. of Forest Resources, G. E. Hart.
Journal of Soil and Water Conservation, Vol. 39, No. 5, p. 330-334, 1 Fig., 4 Tab, 6 Ref.

Descriptors: *Utah, *Rangeland, *Rainfall impact, *Erosion, Soil erosion, Soil water, Rainfall intensity.

Simulated rainfall was applied to large runoff plots that were bare or covered with sagebrush and grass. Soil erosion on the vegetated plots was negligible; on the bare plots soil loss averaged 1.9 t/ha from lower intensity rain on dry soil and 16.6 t/ha from higher intensity rain on prewet soil. Antecedent soil moisture condition had a pronounced effect on erosion. The universal soil loss equation greatly overestimated measured loss on dry soils, but was within 13 to 51% of measured losses on prewetted plots with a 10% slope. Comparison of predicted and measured soil losses on a 32% slope suggested that overestimation was due partly to the USLE's slope value. (Author's abstract)
W85-03354

FIFTY YEARS OF SEDIMENTATION

California Inst. of Tech., Pasadena, CA, V. A. Vanoni, Journal of Hydraulic Engineering, Vol. 110, No. 9, p. 1022-1057, August, 1984, 13 Fig., 1 Tab, 169 Ref.

Descriptors: *Sedimentation, *History, Sediment transport, Entrainment, Erosion, Reviews, Bed load, Suspended sediments, Scour.

The development of sedimentation is traced from the 1930s through the 1970s with key contributions being cited. The term sedimentation includes the processes of erosion, entrainment, transportation, deposition, and compaction of sediment. Much of the research in the early decades of this century dealt with the development of relations for transport of bed load by streams. The developments in the mechanics of turbulent flow which occurred in the early decades of this century were brought to bear on the problem of sediment suspension in the late 1930s. First experiments on local scour were made in 1940 in a study of the scour of sand by vertically oriented jets. Basic studies of bed forms and bed form predictors are cited. A primary objective in sedimentation is to develop relations which will give sediment discharge in terms of hydraulic parameters and bed sediment characteristics. In the 1940s workers concentrated on developing expression for discharge of bed load in which the hydraulic variable is the shear stress. More recently, workers have concentrated on developing what are called total sediment discharge relations, some of which apply the theory of suspension or concepts related to it. Additional work in the following is also cited: hydraulic relations, effect of water temperature, hydraulic geometry, and stream forms. (Baker-IVI)
W85-02263

HYDROLOGY, HYDRAULICS AND SEDIMENT TRANSPORT, KANKAKEE AND IROQUOIS RIVERS

Illinois State Water Survey Div., Champaign, IL, M. Demissie, N. G. Bhowmik, and J. R. Adams.
Report of Investigation 103, 1983. 66 p., 30 Fig., 11 Tab, 22 Ref.

Descriptors: *Hydrology, *Hydraulics, *Sediment transport, *River basins, *River flow, Sediment discharge, Flow discharge, Flow characteristics, Flood routing, Flood control, Storm water, Water surface profiles, Channel Flow, Computer programs, *Illinois, Kankakee River, Iroquois River, Indiana.

The Kankakee is an important resource for both Illinois and Indiana and any alteration of the hydrology or hydraulics of the upstream portion of the river will have a significant impact on the river system in either state. The sediment transport characteristics of the rivers were studied based on three years of suspended sediment data at four gaging stations. Reflecting the combined flows of the upper Kankakee and the Iroquois, the Kankakee near Wilmington is strongly influenced by the Iroquois during flood flows and the upper Kankakee during low flows. Wetlands on the Kankakee, and the differences in geology, drainage area shape, and stream slope are the main reasons for the different flow characteristics between the two rivers. Sandy soils and wetlands in the upper Kankakee Basin also provide underground and surface water storage, thereby reducing peak flows during floods and increasing low flows during dry periods. Sediment transport rating curves, relating daily sediment discharge to average daily water discharge, were developed. The impact of storm episodes was also analyzed at the four stations, and it was found that 50% of the annual sediment load in 1980 moved past three stations in only four to six days. A hydraulic analysis of the Iroquois studied the impacts of channel clearing and snagging using tow computer programs to calculate water surface profiles and to route floods. The results showed decreased water surface elevations and an increase in velocity which will increase bank erosion and, subsequently, total sediment load in the channel. The potential for more frequent flooding also increases. (Atkins-Omniplan)
W83-02921

LAND USE EFFECTS ON SEDIMENT YIELD AND QUALITY

British Columbia Univ., Vancouver, Dept. of Geography, O. Slaymaker.
Hydrobiologia Vol. 91, p. 93-100, July, 1982. 13 Fig., 4 Tab., 68 Ref.

Descriptors: *Sediment yield, *Water quality, *Land use, Sediment transport, Model Studies, Environmental effects.

Attempts to establish land use effects on sediment yield and water quality require considerations of background biogeochemical cycling, quantitative and use mapping, selection of appropriate transport and attenuation models, and the assessment of critical or threshold amounts and types of land use change. Progress in each of these problem areas is reviewed. Specifics considered include the defining transformations in the biogeochemical cycle in the absence of land use change; defining land use categories and changes in sufficiently specific and, where possible, quantitative ways so that the resulting levels achievable in this measurement are compatible with those of land use measurements; define the most appropriate transport and attenuation models which describe the movement of water, sediment, ions, and pollutants through a basin; and defining the criteria by which critical thresholds of land use change can be recognized. (Baker-IVI)
W85-02060

MODELING SEDIMENT DEPOSITION BEHIND CORN RESIDUE

Iowa Cooperative Extension Service, Cedar Rapids, IA, L. G. Brenneman, and J. M. Laflen.
Transactions of the ASAE, Vol. 25, No. 5, p. 1245-1250, September/October, 1982. 9 Fig., 2 Tab, 17 Ref.

Descriptors: *Erosion control, *Model studies, *Slopes, Vegetation, Crops, *Corn, Rainfall, Sedimentation, Erosion, Watershed protection.

A simulation model was developed to predict the amount of sediment deposited behind corn residue in row middle areas. Data generated in a rainfall simulator field study were used for model validation. Observed soil erosion rates compared favorable with erosion rates predicted by the model. The results generated by the simulation model indicate that although differences in soils can change corn residues' effect on soil losses, more influence is exerted by differences in slope steepness. As slope steepness increased, crop residues were less effective in controlling soil erosion. (Baker-FRC)
W83-02455

OVERLAND FLOW AND SEDIMENT DELIVERY: AN EXPERIMENT WITH SMALL SUB-DRAINAGE IN SOUTHWESTERN PONDEROSA PINE FORESTS (COLORADO, U.S.A.)

Rocky Mountain Forest and Range Experiment Station, Tempe, AZ, Forestry Sciences Lab, B. H. Heede.
Journal of Hydrology, Vol. 72, No. 3/4, p. 261-273, June, 1984. 3 Fig., 2 Tab, 18 Ref.

Descriptors: *Overland flow, *Sediment transport, *Pine Trees, *Arizona, *Coconino Plateau. *Surface runoff, *Erosion pavements, *Forest hydrology, Forest watersheds, Runoff volume, Runoff rates.

Overland flow and sediment delivery were studied in 14 small Ponderosa pine forest subdrainages within two 60 ha watershed on the Coconino Plateau of the Colorado Plateau Physiographic Province near Flagstaff, Arizona. The study sites ranged in size from 0.02 ha to 0.3 ha. Runoff and sediment collectors at the bottom of the subdrainages conveyed the water-sediment mixtures into storage tanks. Sediment delivery from undisturbed forest floor practically was nil. Sources for sediment production were roads and erosion pavements and were not universally distributed on the watersheds. Most erosion pavements were the result of selected timber harvest 42 years ago. When undisturbed forest floor was located between the source area and collector, the effect of the source area was offset; increased infiltration into the undisturbed forest floor was responsible by reducing overland flow. Buffer strips are important for reducing sediment delivery in this study area. (Collier-IVI)
W85-01612

RAINFALL-RUNOFF IN SOIL EROSION WITH SIMULATED RAINFALL OVERLAND FLOW AND COVER

M. J. Singer and P. H. Walker.
Austrialian Journal of Marine and Freshwater Research, Vol. 21, No. 2, p. 109-22, 1983, 3 Fig., 6 Tab, 26 Ref.

Descriptors: *Rainfall-runoff relationships, *Soil erosion, *Simulated rainfall, *Overland flow, Straw cover, Agricultural runoff, Surface runoff, Rainfall impact, Rainfall intensity, Sheet erosion.

The relative importance of rainsplash, rain-flow transportation and overland flow alone in sheet erosion may be determined by using a flume and rainfall simulator with soil materials. The 20-100 mm portion of a yellow podzolic soil (Albaqualf) from the Ginninderra Experiment Station (A.C.T.) was used in a rainfall simulator and flume facility to elucidate the interactions between raindrop impact, overland water flow and straw cover as they affect soil erosion. A replicated factorial design compared soil loss in splash and runoff from 50 and 100 mm/h rainfall, the equivalent of 100 mm/h overland flow, and 50 and 100 mm/h rainfall plus the equivalent of 100 mm/h flow, all at 0, 40 and 80% straw cover on a 9% slope. As rainfall intensity increased, soil loss in splash and runoff increased. Within cover levels, the effect of added overland flow was to decrease splash but to increase total soil loss. This is due to an interaction between raindrops and runoff which produces a powerful detaching and transporting mechanism within the flow known as rain-flow transportation. Airsplash is reduced, in part, because of the changes in splash characteristics which accompany changes in depth of runoff water. Rain-flow transportation accounted for at least 64% of soil transport in the experiment and airsplash accounted for no more than 25% of soil transport. The effects of rainfall, overland flow and cover treatments, rather than being additives, were found to correlate with a natural log transform of the soil loss data. The findings have relevance

to predictive models such as CREAMS which are based on erosional processes. (Murphy-IVI)
W84-03875

RAINFALL-RUNOFF SEDIMENT YIELD RELATION BY STOCHASTIC MODELLING

Consiglio Nazionale delle Ricerche, Turin (Italy). Is. di Ricerca per la Protezione Idrogeologica nel Bacino Padano, E. Caroni, V. P. Singh, and L. Ubertini.
Hydrological Sciences Journal, Vol. 29, No. 2, p. 203-218, June, 1984. 4 Fig., 6 Tab, 11 Ref.

Descriptors: *Rainfall-runoff relationships, *Sediment yield, *Model studies, Transfer functions, Noise techniques, Pigeon Roost Creek, Marshall County, Mississippi. Time series analysis.

Two single input stochastic models for obtaining estimates of sediment yield in rivers were developed based on transfer function plus noise techniques and calibrated using previously collected data from Pigeon Roost Creek, Marshall County, Mississippi. Stochastic modeling accounts for the time series nature of rainfall. These techniques are superior to traditional method which make use of discharge-concentration rating curves. The modes were fitted to a calibration set of eight events and then applied to predict and simulate sediment yield for four sets of events. Model calibration requires (a) derivation of an estimate of the impulse response function from the estimated cross-correlation function between the input and output series after 'prewhitening,' (b) fitting the model to the data by minimizing the residual sum of squares, (c) the Box-Pierce statistic obtained from the first k terms of the residual autocorrelation function. If the model proved inadequate, the autocorrelation and cross-correlation functions involving the residuals of the rejected model indicated what modifications were to be made in the transfer function or the noise. The adaptability of these models to real time forecasting schemes was supported and they provided some information about the dependency of sediment yield on rainfall and runoff rates. (Collier-IVI)
W85-01138

RELATION OF USLE FACTORS TO EROSION ON RANGELAND

Purdue Univ., Lafayette, IN, Dept. of Agricultural Engineering, G. R. Foster.
In: Proceedings of the Workshop on Estimating Erosion and Sediment Yield on Rangelands, Tucson, Arizona, March 7-9, 1981, Agricultural Reviews and Manuals ARM-W-26, June 1982, p. 17-35, 3 Fig., 2 Tab, 31 Ref.

Descriptors: *Rangeland, *Soil erosion, *Runoff, *Erosion control, Climate, Soil properties, Topography, Land use, Rainfall, Slopes, Soil conservation, Range management.

Factors in the Universal Soil-Loss Equation (USLE) are measures of the effect of climate, soil, topography, and land use on erosion. The factors are referenced to a unit plot, 72.6 ft long on 95% slope, maintained in tilled, continuous fallow. The USLE is primarily used to inventory erosion under current conditions and to guide the selection of practices to control erosion to a tolerable level. It has been widely applied to cropland in the Eastern U. S. and recently has been extended to Western rangeland. Special considerations are required in this new application because rangeland conditions differ significantly from those used to derive the USLE. The USLE factors are A = RKLSCP, where A = soil loss, R = rainfall-runoff erosivity factor, K = soil erodibility factor, L = slope length factor, S = slope steepness factor, C = cover and management factor, and P = supporting conservation practice factor. The infrequency of rainfall and its great spatial variability in the West are considerations in application of the USLE. Many rangeland slopes exceed 20% or 25%, the upper limit of the data used to develop the S factor. Using present equations for S, the soil loss from steep slopes may be overestimated. The C factor is often the most important factor. At the site, it is the only factor that a range manager may easily change to control erosion. (Moore-SRC)
W83-00096

RELATIONSHIPS BETWEEN MORPHOLOGY OF SMALL STREAMS AND SEDIMENT YIELD

H. H. Chang, W. L. Graf, E. H. Grissinger, H. P. Guy, and W. R. Osterkamp.
Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, Vol. 108, No HY11, p. 1328-1365, November, 1982. 11 Tab, 181 Ref.

Descriptors: *Streams, *Morphology, *Sediment transport, Erosion, Erosion control, Model studies, Mathematical equations, Vegetation, Banks, Flow, Hydraulics, Hydrodynamics, Channels, Canals, Design criteria.

The state of the art in the relations between morphology of small streams and sediment yield is assessed. Research findings and recommendations for additional research are presented. Topics include systems and interactions, simulation models, channel forms and processes, transport of sediment in small streams, and aspects of channel morphology. Simulation models for erosion and sediment yield were reviewed, and their role in providing estimates of the upland input of water and sediment of stream channels was noted. Many of the models include channel erosion and deposition. The presence of a free water surface in open channel flow adds an element of complexity in that depth of flow is free to change in response to changing conditions. Alluvial bed forms and their relation to hydraulic resistance, and, thus, depth discharge formulas, were reviewed and found to differ depending on flow conditions. Self-forming streams in the downstream direction can be patterned as straight, meandering or braided. The patterns and associated temporal and spatial interactions are again seen as complex inasmuch as channel form can affect the gradient and counter-currents and thus channel geometry and sediment

transport capacity. Sediment-transport formulas, the form and structure of stream channels, and regime theory developed from the need for design criteria for sediment carrying canals were reviewed. Calibration of hydraulic geometry equations for natural streams, the synthesis of the erosion and sediment transport methods, the effects of geologic materials, and the influence of bank vegetation on channel erosion and sedimentation were also considered. (Baker-FRC)
W83-02697

RELATIONSHIPS BETWEEN THE POLLUTANTS IN THE SEDIMENTS AND IN THE WATER OFF THE DELAWARE AND RARITAN CANAL

Rutgers — The State Univ., Piscataway, NJ. Coll. of Engineering, M. L. Granstrom, R. C. Ahlert, and J. Wiesenfeld. Water Science and Technology, Vol. 16, No. 5-7, p. 375-380, 1984. 1 Tab, 6 Ref.

Descriptors: *Delaware and Raritan Canal, *New Jersey, *Sediment contamination, Water pollution sources, Polychlorinated biphenysis, Pesticides, Trihalomethanes, Water treatment, Chlorination, Halogenated hydrocarbons, Spoil banks, Interstitial water, Water supply.

The 60-mile-long Delaware and Raritan Canal in New Jersy once served as a barge canal and for the last 30 years has served as a major interbasin water supply system. Approximately 78 mgd are withdrawn; of this, 68.5 mgd is sold to water purveyors for treatment and distribution to some 600,000 people. In addition to the water taken from the Delaware River, the canal receives runoff from 82.7 sq mi of urban and rural land. The canal is severely clogged by sediments in certain segments and to have adequate hydraulic capacity, removal is necessary. Sediments, interstitial water and the overlying water column were analyzed for pesticides, polychlorinated biphenyls (PCBs) and volatile organic halide compounds. PCBs and pesticides were found on some of the sediment samples analyzed. PCBs were found in the water column only in samples taken during a storm. Volatile organic halides including trihalomethanes exist in the water column and in the sediment water, and the concentrations increase significantly upon chlorination. Disposal of the sediments from some sections of the canal should be in landfill and not by spreading on crop lands. (Moore-IVI)
W85-01413

RUNOFF AND SOIL EROSION ON FROZEN SOILS IN NORTHEASTERN OREGON

Agricultural Research Service, Pendleton, OR, Columbia Plateau Conservation Research Center, J. F. Zuzel, R. R. Allmaras, and R. Greenwalt
Journal of Soil and Water Conservation, Vol. 37, No. 6, p. 351-354, November/December, 1982. 4 Fig., 3 Tab, 21 Ref.

Descriptors: *Soil erosion, *Frozen ground, *Snowmelt, Sediment transport, Erosion, Runoff, Rainfall-runoff relationships, *Oregon, Infiltration, Soil loss.

Frozen soils, snowmelt, and rain on snow were key mechanisms in the major soil loss events recorded during the winter of 1979-80 at 4 monitoring sites in north central Oregon. Test sites represented conventionally tilled and planted fields in a wheat-fallow rotation. The 14 erosion-producing runoff events were associated with frozen soils, two with rain only and twelve with snowmelt or rain on snow. As much as 87% of precipitation ran off. Soil losses (tons per ha) were 0.5, 1.1, 29.0, and 31.0 at the 4 sites from January 12 to February 25, 1980. Precipitation intensity was not a major cause of runoff and erosion because most of the rain fell on snow. Large quantities of heat of vaporization were liberated at the snow-air interface by the high dewpoint temperature caused by warm, moist Pacific air masses. This produced a faster snowmelt than expected from sensible heat, radiation, and the heat content of rain. Condensation melt in a typical rain-on-snow event accounted for as much as 38% of total hourly melt and averaged 21% for the entire event. These results indicate that the Universal Soil Loss Equation applied to this region should be corrected for the effects of frozen soil and runoff. (Cassar-FRC)
W83-02826

SEDIMENT CONCENTRATIONS FROM INTENSIVELY PREPARED WETLAND SITES

Clemson Univ., SC, Belle W. Baruch Forest Science Inst., G. R. Askew and T. M. Williams
Southern Journal of Applied Forestry, Vol. 8, No. 3, p. 152-157, August, 1984, 4 Fig., 1 Tab, 12 Ref.

Descriptors: *Sedimentation, *Logging, *Drainage systems, *Bay lands, *South Carolina, *Suspended sediments, Erosion Roads, Drainage ditches, Construction Wetlands, Water pollution sources, Water pollution control.

Conversion of pocosin and bay lands in the southern U.S. from natural hardware stands to loblolly pine plantations usually involves the installation of some form of drainage system followed by logging, site preparation, and planting. The drainage system may provide a pathway for sediment produced by these activities to reach natural streams. Suspended sediment concentrations were measured in water draining from a 5,900-acre Carolina bay located in southeastern Georgetown County, South Carolina, which is undergoing conversion to loblolly pin plantations. Samples were collected during the first storm-flow event of each month between January 1981 and December 1982 from subwatersheds involved in some of several phases of conversion. Suspended sediment concentrations in water draining from the bay averaged 16 mg/l despite logging, site preparation road maintenance and use, and installation of drainage ditches. Road erosion and ditch installation produced the highest suspended sediment concentra-

tions. Suspended sediment concentrations decreased substantially with increasing distance from the sediment source. Logging and site preparation did not lead to increased sedimentation as long as heavy equipment was not allowed to operate in the ditches. Apparently on the flat coastal soils overload flow normally transports sediment only from roads or from disturbed sites immediately adjacent to drainage ditches. One way to minimize th impact of roads and new drainage ditches is to use a drainage system that contains a length of main channel between sediment sources and sensitive areas. (Moore-IVI)
W85-02112

SEDIMENT DELIVERY PROBLEM

Exeter Univ. (England). Dept. of Geography, D. E. Walling.
Journal of Hydrology, Vol. 65, No. 1-3, p. 209-237, August, 1983. 13 Fig., 7 Tab, 87 Ref.

Descriptors: *Sediment transport, *Model studies, Erosion, Sedimentation, Channels, Spatial distribution, Nutrients, Drainage basin, Soil erosion.

The limitations of the sediment delivery ratio concept are reviewed by considering the problems of temporal and spatial lumping and its blackbox nature. Recent advances in the understanding of the sediment delivery system and its modelling are described and the lack of detailed empirical investigations is highlighted. The significance of recent concern for the role of sediments in the transport of nutrients and contaminants to sediment delivery studies is introduced. Appreciation of the wider environmental significance of erosion and sediment delivery processes in the context of material transfer through terrestrial and aquatic ecosystems provides a further need for improved understanding of sediment delivery processes. The lack of empirical studies of the processes, pathways, sinks and time constants involved in the delivery process must hamper progress. Recent advances in distributive modelling of erosion and sediment yield clearly represent a significant advance. (Baker-IVI)
W84-02447

SEDIMENT DEPOSITION IN A FLOOD-RETENTION STRUCTURE AFTER TWO RECORD FLOODS IN SOUTHWESTERN WISCONSIN

Geological Survey, Madison, WI. Water Resources Div., P. A. Kammerer and W G. Batten.
Journal of Soil and Water Conservation, Vol. 37, No. 5, p. 302-304, September/October, 1982. 5 Fig., 1 Tab, 4 Ref.

Descriptors: *Sediment transport, *Floods, *Wisconsin, Sedimentation, Flood control, Erosion, Erosion Control, Drainage basins, Driftless Area, Floodwater retention, Surface runoff.

Sediment deposited in a flood-control structure was measured after record floods in southwestern Wisconsin on June 17 and June 30-July 1, 1978. The structure is in the Driftless Area, where high relief, erodible soils, and land use contribute to high soil losses. The two floods deposited 4.1 acre-feet of sediment in the structure. This translates into a sediment yield of 3,200 tons per square mile from the 2.3 square mile drainage basin. Comparison of this yield to the average annual sediment yield of 13 tons per square mile between 1968 and 1974 illustrates the important of isolated hydrologic events in determining sediment yields in the Driftless Area. (Baker-FRC)
W83-02705

SEDIMENT POLLUTION CONTROL IN NORTH CAROLINA

North Carolina State Univ. at Raleigh, D. H. Howells and H. K. Britt.
Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 108, No. EE6, p. 1228-1247, December, 1982. 2 Fig., 5 Tab, 4 Ref.

Descriptors: *Sediment control, *Revegetation, *Legislation, Water management, *Erosion control, Sediment erosion, Sedimentation, Silting, Highway effects, Vegetation establishment, Water law, Sanitary landfills, Water pollution control, *North Carolina.

A review of state and local sediment control programs in North Carolina in relation to urban and highway construction and sanitary landfill operations is presented. The Sedimentation Pollution Control Act was enacted in 1973 and renewed in 1981 without substantial changes. The mandatory standards of the Act state that where land-disturbing activities are near lakes or natural water-courses, a buffer zone is required to reduce siltation within 25% of the buffer zone nearest the land-disturbing activities. The Act also mandates that the angle of graded slopes and fills can be no greater than that which can be maintained by vegetative cover or other structures, and when land-disturbing activity is undertaken on a track of more than 1 acre, the responsible person must retain sediments within the boundaries of the tract during construction and provide a permanent ground cover sufficient to maintain erosion within 30 working days. The Act also covers aspects of technology and training, management, economics, enforcement, education, and public acceptance. State and local programs for sediment control generally enjoy public support. It is recommended that more local programs be set up, that government at all levels should set an example of sediment control practices for private industry, that greater efforts should be made toward enforcing the Sedimentation Pollution Control Act, and that more funds be allocated to meet these goals. (Geiger-FRC)
W83-03860

SEDIMENT TRANSPORT IN ALLUVIAL CHANNELS RATES FOR EROSION AND DEPOSITION OF COHESIVE SEDIMENTS LITERATURE REVIEW AND EXPERIMENTAL DESIGN

Oklahoma State Univ., Stillwater, OK, Dept. of Chemical

Engineering, J. Wagner and S. P. Kuan.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-206797. Oklahoma Water Resources Research Institute Completion Report, Oklahoma State Univ., Stillwater, March 1983, 65 p., 6 Fig., 1 Tab, 144 Ref., 1 Append. OWRT A-094-OKLA(2), 14-34-0001-1138.

Descriptors: *Erosion rates, *Experimental design, *Open channels, *Sedimentation rates, *Test facilities, Alluvial channels, Channel erosion, Deposition, Fabrication, Flumes, Hydraulic transportation, Open-channel flow, Pumps, Sediment erosion, *Sediment transport, Sediments, Silting, Soil erosion, Soil properties, Suspended sediments, Tractive forces.

Nationally sediment pollution exceeds all other types including those from municipalities and industries. Sediment is recognized as a dangerous multiple pollutant since it may carry other contaminants such as herbicides, pesticides, toxic metals, and plant nutrients adsorbed on particles surfaces. Evaluation of water quality improvements which might be derived from alternative control techniques will require methodologies for predicting the transport and distribution of sediments and associated contaminants in alluvial channels on agricultural and silvicultural watersheds. The mechanisms of hydraulic erosion and deposition of cohesive sediments are extremely complex and depend not only upon the hydraulic regime, but also upon the physicochemical forces between sediment particles. The strength and number of bonds between particles of cohesive sediment are influenced by the sediment mineralogy, mode of deposition, an the chemical quality of the pore and eroding fluids. A review of the literature has been conducted to describe the progress toward understanding the mechanisms of hydraulic erosion and deposition of cohesive sediments. At the present time there are not methods for predicting rates of erosion or deposition which do not require field or laboratory erosion or deposition studies.

An experimental tilting recirculating flume has been designed to acquire data which can be used in empirical models for rates of erosion and deposition of cohesive sediments. It can be used to develop more detailed mechanistic models. Factors which must be considered in the design of a flume which will handle sediment suspensions are discussed, and guidelines for experimental procedures for erosion and deposition studies are outlined.
W83-03032

SEDIMENT YIELDS IN COASTAL SOUTHERN CALIFORNIA

California Inst. of Tech., Pasadena, CA, B. D. Taylor.
Journal of Hydraulic Engineering, Vol. 109, No. 1, p. 71-85, January, 1983. 4 Fig., 2 Tab, 8 Ref.

Descriptors: *Sediment yield, *California, *Coastal plains, California shoreline, Sediment discharge, Sediment distribution, Sediment transport, Sedimentary basins, Sedimentation, Deposition, Sedimentation basins, Sand, Erosion, Performance evaluation.

Of the 33,000 sq. km of coastal drainage in southern California between Point Conception and the U.S.-Mexico border, approximately four-fifths is erosional according to recent geological history. Ninety-four percent of the erosional area debouchs water and sediment into intermediate depositional areas before reaching the coast, with the remaining 6% (smaller coastal streams) draining directly to the shore line. In Southern California the delivery of inland sediments to the coast is important for shoreline stability and the preservation of natural beach areas. During the past several decades, changes in land use and the construction of water conservation and flood control structures have materially affected natural sediment movement and coastal deliveries. To provide a basis for regional sediment management, a study has been undertaken at the California Institute of Technology to quantify natural sediment movements and man's effect on these processes. As a first step in this study, sediment yields from inland areas have been estimated. Results indicate that an annual average of 12 million cu m of sedimentary material are yielded from geologically erosional areas. Of this, 6 million cu m are fine sediments, 5 million cu m are sand, and 0.8 million cu m are coarser than 2 mm. (Murphy-IVI)
W84-04824

SEDIMENT-DELIVERY RATIOS FOR A SMALL COASTAL PLAIN AGRICULTURAL WATERSHED

Science and Education Administration, Tifton, GA, Southeast Watershed Research Lab, J. M. Sheridan, C. V. Booram, Jr., and L. E. Asmussen.
Transactions of the ASAE, Vol. 25, No. 3, p. 610-615, 622, May/June, 1982. 4 Fig., 5 Tab, 22 Ref.

Descriptors: *Coastal plains, *Sediment transport, Watersheds, Rainfall-runoff relationships, Sedimentation, *Sediments, Prediction, Estimating, Seasonal variation, *Agricultural watersheds, Storm runoff, Erosion.

Sediment-delivery ratios were determined for Watershed K, a small complex-cover Coastal Plain agricultural watershed near Tifton, Georgia in order to describe seasonal variations in sediment delivery ratios, and to develop relationships for predicting sediment-delivery ratios for use in engineering-design estimates. Measured total sediment loss from the drainage area was divided by the estimated gross soil movement within the drainage area and then multiplied by 100 to determine sediment delivery ratio (SDR) values for the selected time period. SDR values were examined monthly, seasonally, and annually. Equations suitable for estimating SDR values for periods other than the study period were developed by regression analyses. SDR values were highest during months when neither gross sediment movement nor sediment yields were at annual maximums. The SDR values peaked, instead, during months of moderate gross movement and moderate yield. The variability of SDR values with time throughout the year was

evident. The overall results indicated that the traditional annual-based sediment-delivery ratio in predicting sediment yields on a storm or short-term basis may cause significant errors in estimating the quantity of sediment moving from Coastal Plain drainage areas. Season was the predominate individual predictor of observed variations in SDR values. (Baker-FRC)
W83-00869

SEDIMENTATION AND SEDIMENT ACCRETION IN MICHIGAN COASTAL WETLANDS (U.S.A.),

Michigan Univ., Ann Arbor, MI, Dept. of Chemical Engineering.
R. H. Kadlec and J. A. Robbins, Chemical Geology, Vol. 44, No. 1/3, p. 119-150, May, 1984. 18 Fig., 14 Tab, 19 Ref., NOAA grant NA-80-AA-D-0072.

Descriptors: *Lake sediments, *Wetlands, *Sedimentation, *Lake Michigan, Accretion, Sediment transport, Forest watersheds, Sediment load, Suspended solids, Water quality, Storms.

The net effect of the two wetland systems investigated on the sediment load to the Great Lakes appeared to be negligible. Although Cranberry Bog, a forested bottom land ecosystem, tends to export a good fraction of its organic detritus, the receiving filling-lake-bog system of Cranberry Bog appears to retain much of this material. This was confirmed via radioisotope studies, with cores showing higher accretion rates than in the botton land wetland. The river delta wetland at Pentwater, Michigan, had little sediment trapping ability. Large amounts of water and suspended materials entered this riverine wetland, but no annual average removal was found. Radioisotope studies of cores at selected locations within this system showed little or no accretion in stream channels, and normal accumulation of organic material in non-channel areas. No net annual effect on water quality of the streams as they discharged to Lake Michigan was found. Storm events caused no notable import or export of suspended material. Presumably the sand substrate in the vicinity of all the studied wetlands caused runoff events to be mediated by subsurface flow through this porous soil. These three sand-based coastal wetlands appear to have little net effect on suspended solids. (Baker-IVI)
W85-01103

SEDIMENTATION RATE AND HEAVY METAL POLLUTION IN SEDIMENT IN HARIMA NADA (HARIMA SOUND), SETO INLAND SEA

Hoshika, Akira; Shiozawa, Takayuki (Government Industrial Research Inst., Chugoku, Kure, Hiroshima (Japan)); Matsumoto, Eiji, *Nippon Kaiyo Gakkaishi*; 39: No. 2, 82-87 (Apr 1983). (In Japanese).

Sedimentation rates were determined with the 210Pb technique in six sediment cores from Harima Nada (Harima Sound), Seto Inland Sea. The rate of deposition varies from 0.11 $g\ cm^{-2}y^{-1}$ in the northern part of 0.33 $g\ cm^{-2}y^{-1}$ in the southern part of the basin. A marked increase in copper and zinc content was observed above a depth in the core corresponding to about 1900 A.D. as a result of increasing human activities. Anthropogenic input of copper and zinc decreased slightly after 1970. Natural background levels of copper and zinc in the sediment in this sound are II-16 ppm and 100-120 ppm, respectively. The total amounts of anthropogenic copper and zinc in the sediments were estimated to be 110-180)$g\ cm^{-2}$ and 610-1,280)$g\ cm^{-2}$, respectively. These values constitute 40-50/ of the total sedimentary input of copper and zinc in the sediments since about 1900 A.D.

SETTLING/VELOCITY OF NATURAL PARTICLES

Washinging Univ., Seattle, WA, Dept. of Geological Sciences, W. E. Dietrich.
Water Resources Research, Vol. 18, No. 6, p. 1615-1626, December, 1982. 10 Fig., 6 Tab, 35 Ref.

Descriptors: *Settling velocity, *Sedimentation, Particle shape, Particle size, Shape, Density.

An empirical equation was developed to describe the effects of size, density, shape, and roundness on settling velocity of natural sediments. Data from 14 previous experimental studies were used as a basis. The analysis was done in terms of 4 nondimensional parameters: dimensionless nominal diameter (D), dimensionless settling velocity, the Corey shape factor, and the Powers roundness factor. For high D (large or dense particles) changes in roundness and shape factor produced effects of similar magnitude on settling velocity. Roundness varied much less for natural grains and was less important than shape in control of settling velocity. For a typical coarse sand (Powers roundness of 3.5 and Corey shape factor of 0.7) the settling velocity was 0.68 that of a perfect sphere of the same D. Shape and roundness contributed equally to this reduction in settling velocity. At low D, the effects of roundness and shape were much less. Low roundness caused a greater decrease in settling velocity at low shape factor values than at high shape factor values. This appeared to be a result of increased surface drag on flatter grains. (Cassar-FRC)
W83-02939

SOIL EROSION CONTROL ON OWNER-OPERATED AND RENTED CROPLAND

Missouri Univ. Columbia, MS, Dept. of Agricultural Economics, D. E. Ervin.
Journal of Soil and Water Conservation, Vol. 37, No. 5, p. 285-288, September/October, 1982. 3 Tab, 19 Ref.

Descriptors: *Erosion control, *Conservation, Farming, *Land management, Erosion, Management, Decision making, *Missouri, *Soil erosion.

Data from Monroe County, Missouri, are used to demonstrate that there is less erosion control on rented cropland than on cropland operated by the owner. Effective erosion control on rented cropland, therefore, will re-

quire special features in new conservation programs, such as differential cost-sharing provisions for tenants. The inclusion of a cost sharing program for erosion control in the original lease agreement appears to be an important element. How to promote this type of lease should be an important area of study for state and federal soil conservation agencies. An important first step would be to educate landlords and tenants about the potential benefits of conservation practices and provisions that can be put into a lease. Conservation tillage and contour farming would be significant factors in alleviating the erosion problem. (Baker-FRC)
W84-00020

SOIL EROSION OF SUBARCTIC FOREST SLOPES

Hydrocon, Inc., Fairbanks, AK, J. W. Aldrich and C. W. Slaughter.
Journal of Soil and Water Conservation, p. 115-118, March-April, 1983. 6 Fig., 5 Tab, 18 Ref.

Descriptors: *Soil erosion, *Subarctic zone, *Forest soils, *Slopes, Soil stability, Rill erosion, Sheet erosion, Logging, Clear cutting, Runoff, Vegetation, Mathematical models.

The universal soil loss equations is applied to a study size on the Caribou-Poker Creeks Research Watershed (Alaska) in order to assess the suitability of the equation for predicting sheet-rill erosion in Alaska's interior. When a permafrost-free subarctic setting is stripped of all vegetation from the soil surface, an increase in rainfall erosion is 16 times that produced from an undisturbed forest. The rate difference is from 0.008 ton per acre per year of 0.13 ton per acre per year. Removing the trees from a forested area, with only minor disturbance of ground cover, did not increase erosion. A vehicle trail on permafrost terrain had a very low erosion rate of 0.03 ton per acre per year. Comparison of measured erosion with erosion predicted by the universal soil loss equation indicated that the equation overestimated annual rainfall erosion by an average of 21% and overestimated individual storm erosion by an average of 174%. The standard deviation of the mathematical model was 328%. (Murphy-IVI)
W84-03056

SOIL EROSION POTENTIAL OF RECLAIMED MINED LANDS

Hydroeco-System Research Group, Fort Collins, CO, D. M. Hartley and G. E. Schuman.
Transactions of the ASAE, Vol. 27, No. 4, p. 1067-1073, July/August, 1984. 4 Fig., 5 Tab, 19 Ref.

Descriptors: *Soil erosion, *Land reclamation, *Mulching, *Runoff, Rainfall, Simulation models, Soil water, Erosion, Design storms.

Runoff and erosion from three mulch treatments were measured on a surface coal mine near Hanna, Wyoming. Treatments included no mulch, standing grain mulch and crimped straw mulch. Treatments were subjected to artificial rainfall generated by a portable rainfall simulator during three successive growing seasons. Soil loss data indicate a peak in erosion hazard during the summer following seeding of the perennial species. Soil losses were initially least on the straw mulch and greatest on the no mulch treatments although soil loss differences declined by the third season. Generally, soil loss amount varied directly with ground cover. Runoff data from all treatments indicate a general decline in the infiltration rates during the study period. Vegetation, soil loss and runoff data were used to calibrate a computer simulation model of runoff and erosion. Results obtained indicate small amounts of soil loss even for very infrequent, intense one-hour design storms on moderate slopes regardless of mulching method. Simulations indicated that erosion hazards are highly dependent upon antecedent soil moisture conditions and the time distribution of storm intensities. (Author's abstract)
W85-03398

SOIL EROSION SIMULATION ON SMALL WATERSHEDS: A MODIFIED ANSWERS MODEL

Illinois Univ. at Urbana-Champaign, IL, Dept. of Agricultural Engineering, S. W. Parks, J. K. Mitchell, and J. N. Scarborough.
Transactions of the ASAE, Vol. 25, No. 6, p. 1581-1588, November/December, 1982. 7 Fig., 2 Tab, 26 Ref.

Descriptors: *Soil erosion, *Small watersheds, *Simulation analysis, Mathematical studies, Sediment transport, Sedimentation, Agricultural watersheds, Mathematical models, Erosion rates.

A physically-based soil erosion and sediment transport model whose input parameters may be determined from available information has been developed. This single-event, distributed parameter model, which is based on a fundamental erosion concept, considers typical upland erosion and sedimentation processes of splash erosion, flow erosion, sediment transportation, and deposition. Channel erosion is also included. Total erosion rates are assumed to be the sum of the splash and flow erosion of deposition rates. The model was incorporated with the ANSWERS hydrologic model and tested with data from two small agricultural watersheds of less 10 hectares in area. Hydrologic and sediment discharge simulation results from the model were in agreement with observed data. The model was shown to be applicable to an evaluation not only of temporal variations in sediment yield, but also of spatial variations in net soil erosion contributing sediment yield from a watershed. Further research is needed before the model can be applied to ungaged situations. (Carroll-FRC)
W83-03963

SOURCES SINKS AND STORAGE OF RIVER SEDIMENTS IN THE ATLANTIC DRAINAGE OF THE UNITED STATES

Geological Survey, Denver, CO, R. H. Meade.
Journal of Geology, Vol. 90, No. 3, p. 235-252, 1982. 12 Fig., 3 Tab, 72 Ref.

Descriptors: *Sediment transport, *River basins, *Erosion rates, Fate of pollutants, *Atlantic coast, Sediment discharge, Sediment erosion, Sediment load, Sediment yield, Reviews, Streamflow, Storage, Soil erosion, Reservoir silting, Silting, Flood plains, Marshes, Estuaries, Agriculture, Coastal marshes, Coastal plains, *Coastal streams, Suspended sediment.

Difficulties in modeling sediment on a river basin scale are shown in a review of sediment and its movement in Atlantic drainage rivers. Sediment-streamflow relationships vary widely during seasons and among rivers. Highest sediment concentrations and yields are in southern Piedmont rivers; lowest concentrations and yields are in southern Coastal Plain rivers. In many rivers half the sediment is discharged in 1% of the time and 85-95% of the sediment in 10% of the time. This shows that a given sediment particle spends much time in storage and very little time in transport. On a milennial scale soil erosion is the original source of river sediments. The erosion rate increased dramatically in the 17th century as European settlers cleared forests and started farming. Erosion has been most severe in the lower Piedmont of South Carolina and Georgia. Improved soil conservation practices and a decrease in cropland area have decreased erosion rates. However, so much sediment is in storage in rivers, reservoirs, flood plains, and hillslopes that river sediment loads have not decreased. It is estimated that a century or more will be required to clear valley bottoms of excess sediment. Sediments stored further from the river may take much longer to move through the system. For example, most of the hydraulic mining debris on the Sacramento River flood plain remains where it was deposited 100 years ago. Reservoirs that hold a tenth of the annual water flow can trap 80-90% of inflowing sediment. Severe floods can release large amounts of sediment. Channels below reservoir experience accelerated erosion. The ultimate sinks for river sediments and associated contaminants in the Atlantic drainage are the estuaries and marshlands. Only 5% of the sediment load reaches the continental shelf or deep sea. (Cassar-FRC).
W83-03117

STOCHASTIC PREDICTION OF SEDIMENT YIELDS FROM SMALL COASTAL WATER-SHEDS IN OREGON, U.S.A.

Oregon State Univ., Corvallis, OR, Dept. of Electrical and Computer Engineering, J. VanSickle.
Journal of Hydrology, Vol. 56, No. 2/4, p. 309-323, April, 1982. 4 Fig., 3 Tab, 23 Ref.

Descriptors: *Sediment yield, *Stochastic process, Runoff, *Small watersheds, Watersheds, Model studies, *Oregon, *Sediment transport, Suspended sediments.

A simple stochastic model of sediment yield is applied to data from two small Oregon coast range watersheds, Flynn Creek and Needle Branch. In this region nearly all sediment is transported during brief, distinct runoff events, especially in watershed impacted by logging. To generate sequences of sediment yield events the model combines a runoff event frequency analysis, an event-generating process, and an empirical relationship between sediment yield and discharge. Annual sediment yields are obtained by adding the yields from individual events. The observed annual yields appear to be less variable than predicted from random sums of individual storm event yields. These discrepancies are likely a result of controls by sediment sources not included in the model. During dry years sediment accumulated in channels, and small runoff events carried greater-than-predicted loads. In years with larger runoff events observed yields were less than predicted because of flushing during the first large event. The model used here can successfully synthesize reliable long-term sediment yield distributions as long as several years of sediment data are available and sediment supplies and yields are relatively stationary. (Cassar-FRC)
W83-01053

SUSCEPTIBILITY OF AGRICULTURAL SOILS TO INTERRILL EROSION

Agriculture Research Service, Oxford, MS. Sedimentation Lab.L. D. Meyer and W. C. Harmon.
Soil Science Society of America Journal, Vol. 48, No. 5, p. 1152-1157, September/October 1984. 1 Fig., 5 Tab, 17 Ref.

Descriptors: *Erosion, *Interrill erosion, *Soil conservation, Soil properties, Rill erosion, Calcium, Organic matter, Soil erodibility.

Soil losses from crop row sideslopes were evaluated for 18 soils in a bare, tilled condition to determine their relative susceptibilities to interrill erosion. Erodibilities varied by a ratio of > 10:1 for the initial run by 4:1 for succeeding runs. The poorly aggregated high-silt soils were most erodible, and the high-clay soils were least erodible. Simple correlations of interrill erosion with various soil properties were determined. Erosion was best correlated with clay (< 2 micro m) percentage, 1500 kPa water, exchangeable calcium, sum of exchangeable bases, cation exchange capacity, and organic matter content, all negatively. Interrill erosion was well correlated (positively) with the site specific K-factor of the universal soil loss equation. (Author's abstract)
W85-02876

TEMPERATURE/SEDIMENT MODEL FOR A SHALLOW LAKE

Minnesota Univ., Minneapolis, MN, St. Anthony Falls Hydraulic Lab., H. G. Stefan, S. Dhamotharan and F. R. Schiebe. Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 108, No. EE4, p. 750-765, October, 1982, 10 Fig., 27 Ref.

Descriptors: *Suspended sediment, *Reservoirs, *Stratification, Water temperature, Temperature, Turbidity, Model studies, Shallow water, Lake Chicot, *Arkansas, Oxbow lakes, Water quality control, Fate of pollutants, Mixing, Albedo, Dissolved solids.

A model (RESQUAL) formulated for the effects of turbid water inflow into Lake Chicot, Arkansas, a shallow oxbow lake, is described. The model was designed to assist in rehabilitation of the lake, which lost its recreational attraction because of a flood in 1927, levee construction, and increases in row cropping in the watershed. The dynamic, unsteady, one-dimensional numerical model predicts water temperature, suspended sediment concentration, and dissolved solids. It considers energy exchange at the air-water interface as the forcing mechanism for stratification and mixing as well as inflow, outflow, and suspended and dissolved material loading from the inflow. The four major submodels predict: (1) surface heat transfer and temperature stratification, (2) suspended sediment diffusion and settling, (3) inflow and outflow in the presence of density stratification, and (4) dissolved material transport. Turbidity in the reservoir increases surface albedo and diffuse radiation attentuation. These affect water temperature and the strength of temperature stratification. The density stratification structure is dominated by water temperature. Suspended and dissolved solids increase water density by very small amounts. Inflowing water, sometimes containing 1000 ppm suspended sediment, can spread on the lake surface. Sinking turbidity currents form, not at highest turbidity, but at lowest inflow water temperature. Predictions of water temperature and suspended sediment concentration in the lake for a one year period agreed well with observed data. The model may also be used in design of detention basins and sediment trapping basins. (Cassar-FRC)
W83-01545

TESTING THE MODIFIED UNIVERSAL SOIL LOSS EQUATION

Agricultural Research Service, Temple, TX, J. R. Williams.
In: Proceedings of the Workshop on Estimating Erosion and Sediment Yield on Rangelands, Tucson, Arizona, March 7-9, 1981, Agricultural Reviews and Manuals ARM-W-26, June 1982, p. 157-165, 4 Tab, 12 Ref.

Descriptors: *Soil erosion, *Runoff rates, *Mathematical models, *Runoff volume, Erosion control, Storm runoff, Hydrologic models, Slopes, Climate, *Watershed management.

The Modified Universal Soil Loss Equation (MUSLE) was developed by replacing the rainfall energy factor of the USLE with a runoff energy factor. The MUSLE runoff energy factor is a function of the product of the runoff volume and the peak runoff rate for an individual storm. The MUSLE was tested with data from 102 watersheds located throughout the U. S. These watersheds provided a wide range in watershed an climatic characteristics and management strategies. In tests using measured runoff data, MUSLE generally gave satisfactory results, but two possible deficiencies were discovered: the LS (slope length and steepness) factor may not be adequate for flat slope watersheds; and there may be a tendency for MUSLE to overpredict small storms and underpredict large ones. The runoff energy and erosion control practice factors need attention. MUSLE was linked with an expanded version of the CREAMS daily rainfall hydrology model to provide estimates of the runoff factor. The new hydrology-sedimentation model called SWRRB (Simulator for Water Resources on Rural Basins) shows promising results although some of the tests are not complete. (Moore-SRC)
W83-00107

THE USE OF REMOTE SENSING TECHNIQUES AND THE UNIVERSAL SOIL LOSS EQUATION TO DETERMINE SOIL EROSION

Idaho Univ., Moscow, ID, Dept. of Forest Resources, K. M. Schuchard and L. C. Tennyson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-182006, Price codes: A03 in paper copy, A01 in microfiche. Idaho Water and Energy Resources Research Institute, Moscow, Completion Report, January 1983. 25 p., 3 Fig., 22 Ref. OWRT A-080-IDA(1), 14-34-0001-2114.

Descriptors: *Soil erosion, *Remote sensing, *Landsat data, Agriculture, Forest and range lands, VICAR/IBIS image processing, Cover type identification, Universal soil loss equation, Annual soil erosion, Annual soil loss tolerance, *Idaho, Hangman Creek.

Satellite data with ancillary watershed information was used to determine soil erosion of agriculture, forest and range lands in the souther portion of the Hangman Creek watershed, Benewah County, Idaho. Vegetation cover types derived from satellite data and the VICAR/IBIS image processing computer software package were determined with 89% accuracy. The vegetation cover types identified on the study area were dense-mixed forest, medium density mixed forest, ponderosa pine forest, wheat, lentils, barley, bluegrass, pasture and brush. Soil erosion (tons/acre/year) was estimated with the Universal Soil Loss Equation. Annual soil loss in the study area ranged from 0.003 tons/acre/year in the dense to mixed-forest cover type to IX/18.7 tons/acre/year in the wheat and lentil cover types. Annual erosion was compared with the annual soil loss tolerance to determine critical erosion areas.
W83-02326

TOWARDS A BETTER DEFINITION OF THE THREE TYPES OF SEDIMENT TRANSPORT (POUR UNE MEILLEURE DEFINITION DES TROIS TYPES DE TRANSPORT DE SEDIMENTS)

Eidgenoessische Technische Hochschule, Zurich (Switzerland) Inst. fuer Hydromechanik und Wasserwirtschaft, A. Gyr.
Journal of Hydraulic Research, Vol. 21, No. 1, p. 1-15, 1983. 4 Fig., 4 Tab, 20 Ref.

Descriptors: *Sediment transport, *Sedimentation, *Fluid mechanics, *Turbulent flow, *Statistical models, Bed load, Wash load, Saltation, Suspended load, Vortices, Eddies.

It is common to separate the sediment transport of rivers into bed load, wash load and suspended load; however, there are no unique criteria for distinguishing between the three types of loads. The distinction between saltation (leaping into the flow and then resting on the bed) and suspension delimits two methods of hydraulic transportation which follow different laws. Sediments which move as surface creep or saltation and which are supported by the bed, are called bed load. Sediments which are suspended are supported by flow are called suspended load. Wash load is that fraction of the total amount of transported sediment that is not in the bed layer. Using the concept of coherent structures for turbulent flow, only the shear events (burst phenomena) are able to transport the larger grain sizes of the sediment. Coherent structures are vortex elements of shearlayer areas which are interacting with each other in a deterministic way. The new description for sediment transport is composed of a determinate part for modeling the interaction of the sediment particles with the organized motion and a statistical formulation which takes care of the distribution of the events and of the statistical distribution of their convective motion. A consistent set of criteria for defining the three types of loads was developed. (Collier-IVI)
W85-01227

TRANSPORT OF SAND-SIZED SEDIMENT ALONG CROP-ROW FURROWS

Agricultural Research Service, Oxford, MS, Sedimentation Lab, L. D. Meyer, B. A. Zuhdi, N. L. Coleman, and S. N. Prasad.Transactions of the ASAE, Vol. 26, No. 1, p. 106-111, 1983. 1 Fig., 2 Tab, 15 Ref.

Descriptors: *Sediment transport, *Erosion control, Sand, Rainfall-runoff relationships, Sedimentation, Erosion.

Sediment transport capacity was evaluated along simulated crop row furrows as influenced by furrow grandient, flow rate, sediment size and the presence or absence of rainfall. Only sand-sized sediment of single-particle density was studied. Four sand size groups average 77, 151, 302, and 603 micrometers for furrow gradients of 0.2, 1.0, 2.5, and 5.0% at flow rates of about 26, 39, 52 and 65 kg/min with and without intense simulated rainfall. Sediment transport capacity increased rapidly as furrow gradient increased. The capacity was very small at 0.2%., but it became quite large at gradients above 1%. Transport capacity increased as flow rate increased, but the effect was less than that of furrow gradient. Transport capacity generally increased as particle size decreased below 300 micrometers. Rain falling on the furrow flow did not appreciably affect sediment transport for the conditions tested. The mode of sediment transport changed from isolated barchan dunes to transverse bars to streaky sheets of sediment as the furrow gradient increased. Development of the streaky sheet mode of transport was delayed by rainfall, and the change from bars to streaks occurred at about 1% gradient. (Baker-FRC)
W84-00186

USE OF EROSION MODELS ON WESTERN RANGELANDS

Bureau of Land Management, Boise, ID, K. A. Gebhardt. In: Proceedings of the Workshop on Estimating Erosion and Sediment Yield on Rangelands, Tucson, Arizona, March 7-9, 1981, Agricultural Reviews and Manuals ARM-W-26, June 1982, p. 39-46, 1 Fig., 3 Tab, 11 Ref.

Descriptors: *Soil erosion, *Rangeland, *Grazing, *Mathematical models, Vegetation, Environmental Impact Statement, Range management, Sediment yield, Resources management.

Soil loss and sediment yield equations have received greater use on western rangelands in recent years largely because of the emphasis on quantitative impact analysis. The available soil loss equations have been used in many grazing Environmental Impact Statements (EIS) to estimate existing soil loss and to predict soil loss due to changes in vegetative cover, but manages may place too much validity on the estimates when the differences are too small to be considered significant. Limitations of the soil loss estimates should be explained to avoid misuse in application. Universal Soil Loss Equation (USLE) estimates are generally most accurate with slop lengths of less than 400 ft and slopes from 3 to 18% having consistent cropping and management systems. Since the USLE is empirically derived, these limitations do not favor wide application to rangeland without extensive field validation. Rangeland limitations of soil loss equations can be quite extensive. Application of available erosion methodologies must be geared toward solving problems associated with resource use. The erosion model must be designed for the needed application and be sensitive to changes in manageable characteristics (those which can be affected by management actions). (Moore-SRC)
W83-00097

A NON-EQUILIBRIUM APPROACH TO MODELING METAL SPECIATION IN ACID AQUATIC SYSTEMS: THEORY AND PROCESS EQUATIONS

Savannah River Ecology Lab., Aiken, SC, T. D. Fontaine, III.

Ecological Modeling, Vol. 21, No. 4, p. 287-313, March, 1984. 10 Fig., 5 Tab, 43 Ref. Department of Energy contract DE-AC09-76SR00819.

Descriptors: *Mathematical equations, *Algorithms, *Metals, *Aquatic environment, Chemical speciation, Speciation, Heavy metals, Ion exchange.

A general algorithm (NONEQUI) was developed to simulate reversible sorption and ion exchange kinetics among a variety of heavy metals and substrates in acid (pH less than 6.5) lake or stream environments. Competitive metal-substrate and substrate-substrate interactions are modeled as kinetic processes rather than invoking an instantaneous equilibrium assumption. This distinction from other models offers certain advantages when attempting to predict the fate, speciation, transport and ultimately biological effects of toxic metals in dynamic media such as lakes and streams. (Author's abstract)
W84-04676

APPLICATION OF RISK AND UNCERTAINTY ANALYSIS TECHNIQUES TO A HEAVY METAL SPECIATION MODEL

Savannah River Ecology Lab., Aiken, SC, T. D. Fontaine, III.

Ecological Modeling, Vol. 22, No. 1-4, p. 101-108, 1983/1984. 7 Fig., 1 Tab, 2 Ref. DOE Contract DE-AC09-76SR00819.

Descriptors: *Risks, *Uncertainty, *Model studies, *Heavy metals, *Chemical speciation, *Simulation, Toxicity, Sorption, Cation exchange, Water pollution effects.

In every model there is a degree of uncertainty associated with every coefficient that controls the flow of material from one state variable to another. Because of this source of uncertainty, many simulations, each with different (but reasonable) estimates of coefficient setting should be made so as to approximate the probable behavior space of the system of interest. Deterministic models do not account for variability in output response caused by uncertain estimates of coefficients. This can cause their predictions to be of limited value in certain instances. One such instance occurs when trying to simulate the potential risk to the environment that might be incurred as a result of toxic metal inputs. If the uncertainty in coefficients that govern the kinetics of metal sorption and cation exchange reactions with particulate and dissolved substrates is accounted for, a range of values for endpoint concentrations of unbound (toxic) metal species would be expected. Each individual endpoint concentration from the range of simulated values can be tested against a pre-specified threshold concentration level that if exceeded is said to constitute a risk to the environment. If the threshold concentration is not exceeded, then no risk can be said to have occurred. By noting the number of times out of the total number of simulations that a risk threshold level is exceeded, the probability of risk can be calculated. Conversely, making an assessment of risk based on one endpoint concentration from a deterministic model gives little insight into the probability of a risk occurring. The degree of risk should be expected to change as our certainty in coefficient estimates increases or decreases. (Author's abstract)
W85-00259

CADMIUM ADSORPTION IN FRESHWATERS-A QUANTITATIVE APPRAISAL OF THE LITERATURE

Edinburgh Univ. (Scotland), Dept. of Geology. D. P. H. Laxen.

The Science of the Total Environment, Vol. 30, p. 129-146, September, 1983. 5 Fig., 6 Tab, 55 Ref.

Descriptors: *Cadmium, *Adsorption, Literature reviews, Hydrogen ion concentration, Suspended sediments, Iron oxides, Clays, Silica, Humic substances, Manganese oxides, Sediments.

Information from 33 studies of cadmium, adsorption on amorphous and crystalline hydrous iron oxides, clays, silica, humic solids, manganese oxides and natural sediments has been collated. The results have been transferred to a unified data base using a surface complexation model, and are presented in terms of conditional adsorption constants as a function of pH. The adsorption constants for a given substrate at a fixed pH generally agree with an order of magnitude. This is reasonable given the wide range of experimental conditions employed. The affinity of the substrates (on a weight basis) for cadmium appears to follow the order Mn > Fe am > chlorite (montmorillonite) > Fe cryst = ilite = humics > ksolinite > silica. Application of the experimental conditional adsorption constant for the individual substrates to a model suspended sediment predicts adsorption levels similar to those found in experiments with real sediments. The results confirm the potentially important role played by hydrous oxides of iron and manganese. They also emphasize that cadmium is in a very dynamic regime with respect to adsorption in many freshwaters. Deficiences in our present information on cadmium adsorption are highlighted and suggestions made for future studies. (Author's abstract)
W84-04751

CHEMICAL PARTITIONING OF CADMIUM, COPPER, NICKEL AND ZINC IN SOILS AND SEDIMENTS CONTAINING HIGH LEVELS OF HEAVY METALS

Oregon State Univ., Corvallis, OR, Dept. of Soil Science, M. G. Hickey and J. A. Kittrick.
Journal of Environmental Quality, Vol. 13, No. 3, p. 372-376, July-September, 1984. 1 Fig., 3 Tab, 34 Ref.

Descriptors: *Heavy metals, *Soil chemistry, *Cadmium, *Copper, *Zinc, *Nickel, Chemical reactions, Soil contamination, Sediment contamination Geochemistry, Fate of pollutants, Organic matter, Carbonates, Oxides.

Three soils and a sediment which had undergone prior massive additions of heavy metals were sequentially extracted so that Cd, Cu, Ni, and Zn could be partitioned into five operationally defined geochemical fractions: exchangeable, bound to carbonates, bound to Fe-Mn oxides, bound to organic matter, and residual. While the sequential extraction procedure employed in this study cannot identify the actual forms of a given metal in the soil, it appears to be useful for categorizing the metals within several general geochemical fractions. The various geochemical fractions are operationally defined by an extraction sequence that follows the order of decreasing solubility. The Fe-Mn oxide and residual fractions proved to be the most important for the soils and sediment examined in this study, and contained high levels of Cd, Cu, Ni, and Zn. The carbonate fraction, however, was of about equal importance, as the Fe-Mn oxides fraction, in binding metals for those samples containing appreciable quantities of inorganic C. Copper was the only metal to evidence significant association with the organic fraction. A majority of the Cd and an appreciable portion of the Zn in the four samples was exchangeable, which is the first fraction to be extracted, and hence the most soluble. For the sequential extraction procedure used in this study, mobility and biological availability are assumed to decrease in the order of the metal extraction sequence. On this basis, the apparent mobility and potential bioavailability of the metals for the four highly contaminated soils and sediment are: Cd > Zn > Cu = Ni. (Baker-IVI)
W85-01284

CHEMICAL PARTITIONING OF CADMIUM, COPPER, NICKEL AND ZINC IN SOILS AND SEDIMENTS CONTAINING HIGH LEVELS OF HEAVY METALS

Hickey, M. G.; Kittrick, J. A. (Washington State Univ., Pullman, WA). *Journal of Environmental Quality*; 13: No. 3, p. 372-376 (Jul-Sep 1984).

Three soils and a sediment which had undergone prior massive additions of heavy metals were sequentially extracted so that Cd, Cu, Ni, and Zn could be partitioned into five operationally defined geochemical fractions: exchangeable, bound to carbonates, bound to Fe-Mn oxides, bound to organic matter, and residual. Metal recoveries were within + / − 10% of the independently measured total Cd, Cu, Ni, and Zn concentrations. The highest amount of Cd (ca. 37%) was found in the exchangeable fraction, the Cu was the only metal significantly associated with the organic fraction. The Fe-Mn oxide fraction contained 23, 24, 26, and 39%, and the residual fractions 15, 34, 55, and 14% of the Cd, Cu, Ni, and Zn, respectively. The amount of Cd in the residual fraction was 50 times higher than typical for unpolluted soils. Assuming that mobility and biological availability are related to the solubility of the geochemical form of the metals and decreases in the order of extraction, the apparent mobility and potential metal bioavailability for these highly contaminated soils and sediment is: Cd > Zn > Cu > = Ni.

CHROMIUM IN WATER, SUSPENDED PARTICLES, SEDIMENTS AND BIOTA IN THE TRAJA RIVER ESTUARY

Universidade Federal do Rio de Janeior (Brazil), Inst. de Biofisica, W. C. Pfeiffer, M. Fiszman, L. D. DeLacerda, M. Van Weerelt, and N. Carbonell.
Environmental Pollution, Series B, Vol. 4, No. 3, p. 193-205, 1982. 1 Fig., 7 Tab, 14 Ref.

Descriptors: *Fate of pollutants, *Chromium, *Bioindicators, *Estuaries, *Bays, *Bottom sediments, *Biological magnification, *Barnacles, Heavy metals, Indicators, Suspended solids, Suspended sediments, Monitoring, *Brazil, Iraja River estuary, Guanabara Bay, Pollutant identification, Outfalls, Spectrophotometry.

The levels of chromium (Cr) in samples of water, suspended particles, bottom sediments, fish (Poecilia reticulata), plants (Paspalum vaginatum, sesuvium portulacastrum, Philoxeros vermicularis), soils, and barnacles (Balanus sp) collected from August 1976 to September 1980 from the Iraja River and its estuary were measured. Sediment and water samples from the Iraja River had Cr levels a thousand times greater than the published data for freshwater systems. Cr was carried by particulate matter to Guanabara Bay. Cr from water of sediments was concentrated by fish and emergent grass and returned to the system as detritus. The vegetal community displayed a concentration factor smaller than that of soil and prevented the return of Cr to the waters of the estuary. Balanus sp. of the Guanabara Bay concentrates Cr in soft tissues 10000 times higher than values found in suspended particles, and may be used as a biological monitor for this heavy metal in estuarine systems. (Geiger-FRC)
W83-01764

COMPLEXATION OF TRACE METALS BY ADSORBED NATURAL ORGANIC MATTER

Geological Survey, Miami, FL, Water Resources Div., J. A. Davis.
Geochimica et Cosmochimica Acts, Vol. 48, No. 4, p. 679-691, April, 1984. 11 Fig., 4 Tab, 26 Ref.

Descriptors: *Trace metals, *Adsorption, *Organic matter, *Complexation, Chemical speciation, Alumina, Colloids, Natural waters, Copper, Cadmium, Fate of pollutants.

Adsorption is significant is regulating the concentration of dissolved trace metals in natural waters. Modeling approaches for adsorption have been based on studies on colloidal hydrous oxides in the absence of organic matter. The adsorption behavior and solution speciation of Cu(II) and Cd(II) were studied in model systems containing colloidal aluminia particles and dissolved natural organic matter. At equilibrium a significant fraction of the alumina surface was covered by adsorbed organic matter. Cu(II) was partitioned primarily between the surface-bound organic matter and dissolved Cu-organic complexes in the aqueous phase. Complexation of $Cu(2+)$ with the functional groups of absorbed organic matter was stronger than complexation with uncovered alumina surface hydroxyls. The complexation of Cu(II) by adsorbed organic matter can be described by an apparent stability constant approximately equal to the value found for solution phase equilibria. Cd(II) adsorption was not significantly affected by the presence of organic matter at the surface, due to weak complex formation with the organic ligands. Models of particle/trace element interactions which are based on the surface chemistry of clean hydrous oxides may not be directly applicable to natural systems. The suspended particle concentration in many natural waters is low enough that a large percentage of the surface area may be covered with organic matter. (Moore-IVI)
W85-00296

COMPLEXING OF METAL IONS IN NATURAL WATERS

Akademiya Nauk URSR, Kiev, Inst. Hidrobiologii, P. N. Limnik and B. I. Nabivanets.
Hydrobiologia, Vol. 19, No. 3, p. 71-85, 1983. 1 Fig., 4 Tab, 92 Ref.

Descriptors: *Complexing, *Metals, *Ions, *Natural waters, *Literature review, Organic compounds, Chemical properties, Mathematical equations, Humic substances, Inorganic compounds.

In recent years exhaustive studies have been undertaken to determine the state of metal ions in natural waters, including their complexing. The results are extremely important both in scientific explanation of the physiological effect of metals on aquatic organisms and in the solution of a number of practical problems. Some of which concern the development of effective measures for the removal of metals from potable and industrial waters, the development of hydrochemical techniques of search for minerals, prediction of the chemical composition of natural waters polluted by industrial and agricultural effluents. A review of the literature on complexing of metal ions in natural waters is presented. Complexing properties of compounds most characteristic of natural waters, and the mechanisms of metal ion binding to form complexes are discussed, as are various techniques for studying complexing. Stability constant logarithms are given for complexes of metals with humic instances and other organic compounds of natural basin. Complexing affects a large fraction of metals present in natural water, enhancing their mobility and their ability to migrate in solution. Fresh water metal complexes were predominately humic substances, whereas seawater metal complexes were predominately inorganic forms. (Murphy-IVI)
W84-04734

COMPUTATION OF THE INDEX OF POLLUTIONS CAUSED BY HEAVY METALS IN RIVER SEDIMENT

Nippon Inst. of Tech., Saitama, Applied Statistics Lab, H. Nishida, M. Miyai, F. Tada, and S. Suzuki.
Environmental Pollution, Series B, Vol. 4, No. 4, p. 241-248, 1982. 2 Fig., 2 Tab, 8 Ref.

Descriptors: Metals, *Sediments, *Pollution index, Fate of pollutants, *Heavy metals, Rivers, *Japan, Estuaries, Copper, Zinc, Lead, Cadmium, Path of pollutants.

Heavy metals levels were measured in sediments from 92 Japanese rivers to develop an index of pollution (t) based on the idea that the upper 10% of the distribution of t for a standard group of rivers is considered polluted. Hydrochloric acid soluble Cu, Zn, Pb, and Cd data from upstream sediments produced a critical point pollution value of 2.57 for the four heavy metals. Metals levels in the estuary sediments of the same rivers showed that 35 rivers had pollution indexes greater than 2.57. These polluted rivers included the Tama, Tsurumi, Syonai, and other urban rivers as well as rivers such as the Jintsu and Kitakami, passing through mining area. In general the rivers of the Tohoku and Kanto districts, along the shore of the Seto Inland Sea, and along the Hokuriku coast had t values higher than 2.57. Most rivers in the Hokkaido and Sanin districts were considered unpolluted. (Cassar-FRC)
W83-03049

COPPER AND CADMIUM UPTAKE BY ESTUARINE SEDIMENTARY PHASES

Davis-Colley, R. J., Nelson, P. O., Williamson, K. J. (Oregon State Univ., Corvallis) *Environmental Science and Technology*; 18: No. 7, 491-499 (Jul 1984).

An understanding of the distribution of toxic trace metals and other materials of environmental interest among the different sedimentary phases is necessary to assess the hazard associated with pollution of aquatic sediments. A simple model, analogous to speciation in solution among soluble ligands, was developed to enable the distribution of metals within sediments to be estimated. The model requires the conditional metal binding constants (slopes of the linear portions of the adsorption isotherms) to be evaluated for a small number of model sedimentary phases in isolation, as well as knowledge of the composition of the sediment and water. The model has been applied to the distributions of copper and cadmium in estuarine sediments and predicts that iron and organic matter are the sedimentary constituents of greatest importance for these metals. Manganese phases may contribute to cadmium binding, but clay minerals and (probably) aluminosilicates are insignificant sinks for both copper and cadmium. The model predictions for copper and cadmium in estuarine sediments are in good semi-quantitative agreement with the results of selective extraction studies on natural sediments reported in the literature and studies reported here of cadmium uptake by natural sediments.

COPPER IN THE INTAKE AND DISCHARGE ZONES OF THE SURRY AND SALEM NUCLEAR POWER STATIONS (NURER/CR-2965)

Harrison, F. L.; Bishop, D. J.; Rice, D. W., Jr.; Knezovich, J. P. (Lawrence Livermore National Lab., CA (USA)). Feb 1983. Contract W-7405-ENG-48. 51p. (UCRL-53325). NTIS, PC A04/MF A01 – GPO. Order Number DE83011270.

Copper concentrations were measured in the soluble and particulate fractions of water samples and bedload sediments collected in intake and discharge areas of the Surry and Salem Nuclear Power Stations during normal operations. Additional samples of water suspended particles were collected during startup of Unit 2 at the Salem Power Station. In water samples collected from Surry, total copper ranged from 6.5 to 24.7 and labile copper from 0.5 to 2.9 μg/L; in those from Salem, total cooper ranged from 6.7 to 10.6 and labile from 0.9 to 3.8 μg/L. At both sites the highest total copper concentration was measured in January 1979 during a period of high runoff. In general, differences between influent and effluent waters were small; the maximum was 4.2 μg Cu/L. Copper concentration in the water during startup of Unit 2 of Salem was high initially ($>$ 2500 μg Cu/L) but was almost entirely in the particulate fraction; labile copper was only 0.6 μg/L. The apparent complexing capacity (ACC) of the waters from Surry ranged from 6 to 40 and those from Salem from 5 to 60 μg Cu/L. Ranges in dissolved organic carbon were smaller, 2.9 to 5.1 and 2.2 to 5.0 mg C/L for Surry and Salem, respectively, and showed no relationship with ACC. Ultrafiltration of discharge waters indicated that, in most samples, the largest fraction of copper in the untreated water was in the $>$ 10,000 $<$ 100,000 molecular weight fraction; in waters treated to destroy dissolved organic carbon, it was generally in the $>$ 100,000 molecular weight fraction. Copper concentrations in intact bedload sediments from the intake area of Surry ranged from 2.3 to 26 and of Salem from 36 to 74 μg/g dry weight; those in the discharge area of Surry ranged from 13 to 30 and of Salem from 3 to 67. We noted considerable spatial heterogeneity both at the intake and discharge areas, and higher copper concentrations in the $<$ 62-μm fraction than in intact sediments.

COPPER SPECIATION IN SOFT, ACID HUMIC WATER: EFFECTS ON COPPER BIOACCUMULATION BY AND TOXICITY TO SIMOCEPHALUS SERRULATUS (DAPHNIDAE)

Michigan State Univ., East Lansing, MI, J. P. Giesy, A Newell, and G. J. Leversee.
The Science of the Total Environment, Vol. 28, p. 23-36, June, 1983. 2 Fig., 9 Tab, 52 Ref. DOE contract DE-AC09-76SR00819.

Descriptors: *Copper, *Chemical speciation, *Bioaccumulation, Chelation, Simocephalus, Toxicity. Organic matter, Well water, Pond water, Simulation, Mathematical models.

Comparitive studies were conducted using water from a shallow pond and from a deep artesian well which is the primary water source for the pond. These waters are of very similar water quality, except for higher concentrations of dissolved organic carbon in the pond. The stoichiometry and affinity (conditional stability constants) of Cu chelation by naturally-occurring organic ligands were determined by numerical solutions of Scatchard relationships. These values were then used in the geochemical speciation model, GEOCHEM, to determine the relative importance of each Cu species in dynamic equilibrium with competing metals and ligands. The accumulation of Cu by and toxicity of Cu to the soft water cladoceran Simocephalus serrulatus (Daphnidae) were measured and related to Cu speciation. When 10 micro g Cu/L were added to pond water in the fall, the distribution of Cu was: Cu(+ +), 36.0%; Cu-organic, 63%; CuOH(-), 0.5% and CuSO4, 0.5%. The organics in pond water reduced Cu accumulation and toxicity. When the 24 h-LC50 values were reported as Cu(+ +), this species of copper was more toxic in pond water than well water. The toxicity of Cu may not be directly proportional to Cu accumulation by microcrustaceans. (Moore-IVI)
W84-04738

DISTRIBUTION FUNCTION OF HEAVY METALS IN RIVER SEDIMENT

Nippon Inst. of Tech., Saitama, Applied Statistics Lab, H. Nishida and M. Miyai.
Bulletin of Environmental Contamination and Toxicology, Vol. 32, No. 2, p. 212-219, February, 1984. 2 Fig., 2 Tab, 5 Ref.

Descriptors: *Heavy metals, *Fate of pollutants, *Sediments, Japan, Copper, Chromium, Zinc, Lead, Cadmium, Nickel, Distribution.

Random samples of unpolluted upstream and downstream sediments were obtained at 10 points from the right to left banks of each 92 rivers in Japan. The upstream sediments were taken at unpolluted places and those downstream were taken about 1 km from the river mouth. The quantities of heavy metals soluble in hydrochloric acid were measured. In order to decide the distribution function of each heavy

metal, its AIC was calculated. The AIC is a statistical decision procedure for model fitting. Each heavy metal of river sediment derived from a single source was found to be distributed lognormally. (Baker-IVI)
W84-03707

DISTRIBUTION OF SOME TRACE METALS AND THEIR FLUXES IN THE GENESSEE RIVER, NEW YORK

Reddy, M. M.; Krishnamurty, K. V.; Shpirt, E; Carlson, G. A.; Hetling, L. (New York State Dept. of Health, Albany), *Environment International*; 7: No. 5, 315-323 (1982).

Total and particular metal concentrations, measured during intensive synoptic studies of the Genesee River, NY, correlated with suspended-sediment concentration and river discharge. Dissolved metal concentrations, on the other hand, showed little systematic variation over the length of the river. Metal and sediment fluxes for two elevated discharged periods peaked at a midbasin sampling site. For most metals at most sample sites particulate materials comprised over one-half of the total material. Comparison of particulate material metal concentrations, normalized to the measured suspended-sediment concentration, with basinwide average values shows that sites having low suspended-sediment concentrations had high particulate material metal contents relative to the basin averages, while sites with high suspended-sediment concentration had low metal contents. These results are consistent with a metal transport mechanism in the Genesee River involving: (1) a nearly constant dissolved component, (2) a fine acid-soluble component, and (3) a coarse component that is effectively a neutral diluent in the sediment. Chemical factors, such as sediment organic content, also appear to affect metal transport in the Genesee River.

EFFECT OF SEWAGE SLUDGE ON TRACE ELEMENT MOBILITY IN SOILS

Institute of Soil Fertility, Groningen (Netherlands). Dept. of Soil Biology, R. G. Gerritse, R. Vriesema, J. W. Dalenberg, and H. P. DeRoos.
Journal of Environmental Quality, Vol. 11, p. 359-364, 1982. 5 Fig., 4 Tab, 25 Ref.

Descriptors: *Adsorption, *Land application, *Sludge disposal, *Trace elements, Fate of pollutants, Land disposal, Heavy metals, Metals, Organic matter, Chelation, Leaching.

The adsorption (distribution between solid and liquid phases) of 26 trace elements was studied in the laboratory in a sandy soil and a sandy loam soil. Aqueous solutions used in the experiments were deionized water, salt solutions, supernatant of industrial anaerobically digested sludge, supernatant of domestic sludge, and supernatants of aerated sludges. F, B, and Tc were very mobile in both soils. Mn, Sr, and Sb were highly mobile only in the sandy soil; Mo in the sandy loam soil. In general sludge solutions increased the mobility of elements in a soil. This was attributed to complexation by organic compounds, high background concentrations and high ionic strengths. The effects of these variables were very different among the elements. Equations were developed for predicting the rates of accumulation in soils and concentrations in soil solutions for the trace elements. Other elements studied were Be, V, Cr, Fe, Co, Ni, Cu, Zn, As, Se, Ag, Cd, Sn, Cs, Ba, Hg, Pb, Bi, and P. When adsorption was related to soil organic matter content, the strength of adsorption depended only on pH, increasing with decreasing pH for many elements. (Cassar-FRC)
W83-03893

FLOOD EFFECTS ON THE TRANSPORT OF HEAVY METALS

Bradley, S. B. (Univ. College of Wales, Aberystwyth). *International Journal of Environmental Studies*; 22: No. 3, 225-230 (1984)

This paper is concerned with the effect of river flooding on sediment quality in the case of the river Ystwyth in Wales. It is shown that sediment-associated concentrations of lead, copper, and cadmium vary with the river's discharge, and the form in which they are bound to the sediment varies. The ease with which metals can be removed from sediment influences the bioavailability of the metals. 3 Fig., 2 Tab.

HEAVY METALS AND MANGANESE OXIDES IN THE GENESEE WATERSHED, NEW YORK STATE: EFFECTS OF GEOLOGY AND LAND USE

Whitney, P. R. (Geological Survey, Albany, NY). Journal of Geochemical Exploration: 14: No. 1, 95-117 (Feb. 1981).

Manganese oxide coatings on gravels from 255 sites on tributary streams in the Genesee River Watershed were analyzed for Mn, Fe, Zn, Cd, Co, Ni, Pb, and Cu. The results were compared with data on bedrock geology, surficial geology and land use, using factor analysis and stepwise multiple, regression. All metals except Pb show strong positive correlation with Mn. This association results from the well-known tendency of Mn oxide precipitates to adsorb and incorporate dissolved trace metals. When the effects of varying Mn abundance are allowed for, Pb and to a lesser extent Zn and Cu abundances are seen to be related to commercial, industrial and residential land use. In addition to this pollution effect, all the trace metals, Cd and Ni most strongly, tend to be more abundant in oxide coatings from streams in the forested uplands in the southern part of the area. This probably reflects increased geochemical mobility of the metals in the more acid soils and groundwater of the southern region. A strong Zn anomaly is present in streams draining areas underlain by the Lockport Formation. Oxide coatings in these streams contain up to 5% Zn, originating from disseminated sphalerite in the Lockport and secondary Zn concentrations in the overlying muck soils. The same group of metals, plus calcium and loss on ignition, were determined in the silt and clay (minus 230 mesh) fraction of stream sediments from 129 of the same sites, using a hot nitric acid leach. The amount of manganese in the sediments are low (average 1020 ppM) and manganese oxides are, at most, of relatively minor significance in the tracemetal geochemistry of these sediments. The bulk of the trace metals in sediment appears to be associated with iron oxides, clays and organic matter. (JMT)

HEAVY METALS IN BOTTOM SEDIMENTS FROM THE SAW MILL RIVER, WEST CHESTER COUNTY, NEW YORK, 1981

Geological Survey, Albany, NY, R. J. Rogers.
Northeastern Environmental Science, Vol. 2, No. 3/4, p. 188-197, 1983. 3 Fig., 4 Tab, 9 Ref.

Descriptors: *Bottom sediments, *Heavy metals, *Saw Mill River, *West Chester County, *New York, Grain size, Spatial distribution, Fate of pollutants, Copper, Iron, Zinc, Water pollution sources, Industrial wastes.

Bottom sediments were collected at 20 sites between February and September 1981 to assess the concentration and distribution of heavy metals in the Saw Mill River, which drains a largely urban and industrial area adjacent to New York City. Bottom sediments from six sites were separated into six size fractions to determine the relationship between grain size and metal concentration. Concentrations of seven or more acid-soluble heavy metals were determined in each fraction. Metal concentrations were typically greatest in the less than 63-micrometers (micro m) sediment and decreased with increasing grain size. However, metal concentrations in 1,000- to 2,000-micro m sediment were, in general, higher than in the 250- to 500-micro m and 500- to 1,000-micro m sediment. The 1,000- to 2,000-micro m sediment fraction was selected to study the spatial variation in heavy-metal concentrations because this fraction is least subject to transport and, therefore, a better indicator of source areas. Bottom sediments in the lower 3.0 miles of the river were enriched with copper, lead, and zinc compared to upstream sediments and are considered contaminated. No significant enrichment with iron or manganese was detected. Significant correlations were found between copper and iron, zinc, and iron, and copper and zinc in upstream sediments but not in sediments below river mile 3.7, which suggests that the sources of metals in the upstream part of the basin differ from those downstream. Concentrations of arsenic, cadmium, chromium, cobalt, mercury, and nickel were, in general, at or below the analytical detection limits in the size fraction studied and therefore could not be evaluated. The sediments enriched with copper, lead, and zinc are in the most heavily industrialized part of the basin. (Author's abstract)
W85-00206

HEAVY METALS IN THE LOWER MISSISSIPPI RIVER

Newchurch, E. J.; Kahwa, I. A. (Louisiana State Univ., Baton Rouge). *Journal of Environmental Science and Health, Part A: Environment Science and Engineering*; A19: No. 8, 973-988(1984).

The potential of the water in the Mississippi River in south Louisiana to result in drinking water that exceeds the EPA standards for some heavy metals was studied, using analysis of the river water obtained regularly by the Louisiana Division of Water Pollution Control. Between 1978 and 1983, river water concentrations at individual sampling sites exceeded the drinking water standards 1 to 3 percent of the time for cadmium, chromium and copper; 7 to 9 percent of the time for arsenic and lead; and 18 percent of the time for mercury. Correlations of heavy metals versus total suspended solids (TSS) suggest that arsenic, cadmium and chromium are carried predominantly by the TSS and should be removed in the usual water treatment steps of coagulation followed by settling and/or filtration. Copper and lead appear to be carried, at least partly, in dissolved form, while additional data are needed in the case of mercury.

HEAVY METALS IN THE SURFICIAL SEDIMENTS OF FONTANA LAKE, NORTH CAROLINA

Clemson Univ., SC, Dept. of Environmental Systems Engineering, S. R. Abernathy, G. L. Larson, and R. C. Mathews, Jr.
Water Research, Vol. 18, No. 3, p. 351-354, 1984. 1 Fig., 2 Tab, 19 Ref.

Descriptors: *Heavy metals, *Lake sediments, *Fontana Lake, *North Carolina, Lakes, Sediments, Zinc, Copper, Mercury, Aluminum, Manganese, Iron, Magnesium, Minerals.

Samples of sediment were collected in the main body of Fontana Lake and near the mouths of its major tributaries. Analyses were conducted for magnesium, iron, aluminum, manganese, zinc, copper, and mercury. While the drainage area of the reservoir is primarily forested and rural without major industrial developments, manganese, copper and zinc were present in concentrations similar to areas receiving industrial pollution. Chemical analyses of pyritic materials in the watershed showed relatively high concentration of many of the same means. Therefore, inputs of metal compounds may be expected from lake or reservoir, drainage basins with mineralized deposits. Accumulations of these metals in the sediments may pose a biological risk in the future. This may be especially important should the lake or reservoir acidity increase owing to impacts from acid precipitation upon the soft water system. (Baker-IVI)
W84-03738

IDENTIFICATION OF TOTAL BIOLOGICALLY SENSITIVE FORMS OF TOXIC METAL INPUTS TO AN URBAN AFFECTED RIVER

Washington Univ., Seattle, WA, Fisheries Research Inst, E. D. Thielk and S. P. Felton.

Available from the National Technical Information Service, Springfield, VA 22161 as PB83-208850, price codes, A04 in paper copy, A01 in microfiche. Publication No. FRI-UW-8303, February 1983. 52 p. 15 Fig., 7 Tab, 39 Ref, 1 Append. OWRT A-116-WASH(1), 14-34-0001-1140.

Descriptors: Water pollution, *Heavy metals, *Copper speciation, Polarography, Pollution control, Complexing capacity, Complexometric titration, *Copper, Ligands, Reducible copper, Labile copper, *Pollutant identification, *Washington, Green River, *Voltammetry.

A need for inexpensive approaches for the determination of biologically available forms of copper has been established. Differential pulse anodic stripping voltammetry (DPASV) has been proposed as an inexpensive simple approach for these types of determinations. This study investigated copper speciation at six stations on the Green River, Washington, using DPASV. Measurements included total and DPASV reducible copper concentrations, DPASV complexing capacity of unidentified, naturally occurring ligands, and DPASV complexing capacity of specific copper ligands (PO sub 4, P sub 2 O sub 7, CO sub 3, glycine, citrate, oxalate, and EDTA). No endpoints to complexation reactions were observed for any sample. DPASV measurements in the presence of specific copper ligands demonstrated considerable dissociation of all complexes during deposition phase of the measurement, including copper-EDTA complexes. This phenomenon most likely resulted in determination of excessively high concentrations of reducible copper in river water, and may have accounted for low amounts of apparent complexation. The technical aspects of these measurements and sources of interference were discussed in terms of the data collected. It was concluded that the use of DPASV for making determinations of biologically available copper is limited.
W83-03105

MASS BALANCE MODELING OF HEAVY METALS IN SAGINAW BAY, LAKE HURON

Environmental Research Lab., Duluth, Groose Ile, MI. Large Lakes Research Station, D. M. Dolan and V. J. Bierman, Jr.

Journal of Great Lakes Research, Vol. 8, No. 4, p. 676-694, 1982. 14 Fig., 5 Tab, 28 Ref.

Descriptors: Metals, *Sediments, *Lake sediments, *Fate of pollutants, *Heavy metals, Zinc, Copper, Cadmium, Lead, Saginaw Bay, *Lake Huron, Model studies, Suspended sediments, Adsorption, Sedimentation, Wind-driven currents, Particulate matter, Path of pollutants.

A spatially segmented dynamic mass balance model was developed to describe the concentration of metals (cadmium, copper, lead, and zinc) and suspended solids in the water column and sediment of Saginaw Bay, Lake Huron. About 20,000 data points were obtained at 30 stations during 37 cruises in 1976-78. Suspended sediments were important in controlling metals concentrations. The degree of control was a function of the partition coefficient between adsorbed and dissolved phases of the metal, the suspended solids dynamics of the system, and the magnitude of the sediment reservoir. Metals levels in the water column can decrease due to solids adsorption and sedimentation and increase due to resuspension, usually wind-driven. Total metals concentrations in the water column were most sensitive to settling rates of suspended sediments; dissolved metals concentrations, to the value of the partition coefficient. Large percentages of cadmium (77%) lead (28-38%), and zinc (15-79% were lost to the sediments each year. Copper showed little or no loss. (Cassar-FRC)
W83-02820

METAL BINDING STUDIES OF ORGANIC MATERIALS IN WATER SYSTEMS

North Dakota Univ., Grand Forks, Dept. of Chemistry, D. E. Bartak.

Available from the National Technical Information Service, Springfield, VA 22161 as PB83-265108, Price codes: A06 in paper copy, A01 in microfiche. North Dakota Water Resources Research Institute Completion Report, North Dakota State Univ., Fargo, ND, August 1983, 101 p., 4 Tab, 21 Fig., 76 Ref. OWRT A-077-NDAK(1), 14-34-0001-2136.

Descriptors: *Speciation, *Chromatography, Infiltration, Copper, Phenols, Fulvic acids, Humic acids, Aquatic environment, Chemical reactions, *Pollutant identification, *Trace metals, Electrochemistry, Metal complexes, Water sampling.

The chemical speciation of trace metals in aquatic environments play a key role in their transport, chemical reactions, and biological availability. The nature and concentration of a given trace metal in solution is most important in determining its speciation. This research developed a technique for the quantitation of metal complexes in natural water samples. Using modified size-exclusion chromatography and reversed-phase ion-pair chromatography metal complexes were separated and detected using an electrochemical flow-cell detector. A reverse pulse amperometry mode is used to minimize oxygen interferences in the flow system. Optimum conditions for the chromatographic columns, which utilized a copper(II) eluent at pH = 7.4, including gel particle size, eluate flow rate and concentration of applied sample were determined using a series of polyaminocarboxylic acids. The equilibrium M + L ML is established quickly and is maintained by constant metal ion concentration made to the eluent. This prevents the dissociation of labile complexes. Polyaminocarboxylic acids used in developing the techni-

que were DPTA, EDTA, and TNA. Size-exclusion chromatograms of a series of amino acids, carboxylic acids and phenols were studied in developing the technique. Polyaminocarboxylic acids and natural water ligands were tested on the reversed-phase ion-pair column in preliminary studies to establish its utility for the separation of metal complexes. Detection units for EDTA which had been separated on all three chromatographic systems were calculated.
W83-04003

METAL COMPOSITION OF SOIL, SEDIMENTS, AND URBAN DUST AND DIRT SAMPLES FROM THE MENOMONEE RIVER WATERSHED, WISCONSIN, USA

Dong, A, Chesters, G, Simsiman, G. V. (Univ. of California, Davis). *Water, Air, and Soil Pollution*; 22: No. 3, 257-275 (Apr. 1984).

The Al, Cd, Cr, Cu, Fe, Mn, Ni, Pb, and Zn contents of the sand, silt, and fractions were determined for soils, urban street dust and bottom- and suspended-sediments sampled in the Menomonee River watershed, Wisconsin. The samples were dispersed by ultrasound prior to fractionation. The ultrasound dispersion avoids chemical contamination or alteration resulting from use of chemical dispersants and insures that dispersion of aggregates present in mechanically-sieved samples. Chemical analyses of fractionated samples were more precise than analyses of unfractionated samples in identifying areas in the watershed receiving pollutant inputs. Higher levels of Cr, Cu, Fe, and Ni were found in the coarser particles than in the finer particles of urban street dust samples. The Cd, Pb and Zn contents of some bottom and suspended sediments were greater than in the soils of the watershed. Contents of these metals were correlated significantly with each other in the clay-sized fraction of sediments but not in soils. The metal contents of sediments were largely controlled by vehicular emission.

POLLUTANT-PARTICLE ASSOCIATIONS AND DYNAMICS IN COASTAL MARINE ENVIRONMENTS: A REVIEW

Oak Ridge National Lab., TN, Environmental Sciences Div, C. R. Olsen, N. H. Cutshall, and I. L. Larsen.
Marine Chemistry, Vol. 11, No. 6, p. 501-533, 1982. 8 Fig., 182 Ref.

Descriptors: *Estuarine environment, *Water pollution sources, *Sedimentation, Dynamics, Coastal waters, *Reviews, Chemical reactions, Sediment transport, Fate of pollutants.

This review indicates that many pollutants rapidly become associated with particles in coastal marine environments and that these particles are then effectively trapped in the estuaries. This association may result from ionic sorption and flocculation, organic complexation and flocculation, hydrophobic interactions with particle surfaces, bioaggregation, or sorption and co-precipitation with Mn-Fe hydroxides. The net transport of particles and associated pollutants is downstream in the lower salinity surface layer of an estuary, but as these particles settle to the more saline bottom they may be transported back upstream and trapped by estuarine circulation. The rate of particle-pollutant deposition is generally high and is governed to a great extent by estuarine sedimentary processes. Several processes such as sediment resuspension, diffusion from anoxic sediments, and dredging-dumping operations can reintroduce pollutants to marine waters which had already settled out. Dissolved nutrients that may escape an estuary stimulate productivity in near-shore coastal waters and are rapidly removed by biological processes, frequently forming plankton plumes at estuary mouths. Major removal mechanisms for pollutants in shelf waters include sorption onto resuspended sediments, incorporation into living organisms and sinking of organic debris or boundary-layer scavenging in association with the redox cycling of Mn-Fe hydroxides. Of prime importance in any predictive model is a quantitative understanding of the rates associated with the biogeochemical processes that affect pollutant-particle dynamics. These process-oriented transfer rates include: input rates into the marine environment, exchange rates across the air-sea interface, transport rates in the water column, and transfer into and out of the sediments. Quantitative values for the above transfer rates are needed to determine particle-pollutant fluxes and define how long a pollutant will persist. (Baker-FRC)
W84-00141

POLLUTANT-PARTICLE ASSOCIATIONS AND DYNAMICS IN COASTAL MARINE ENVIRONMENTS; A REVIEW

Olsen, C. R.; Cutshall, N.H., Larsen I.L. (Oak Ridge National Lab., TN). *Marine Chemistry (Amsterdam)*; 11: 501-533 (1982). Contract W-7405-ENG-26.

A wide variety of substances, including known or potential pollutants, become associated with particles in coastal marine environments. This association may result from: (1) ion exchange, precipitation, or hydrophobic interactions with the particle surface, (2) co-precipitation with iron and manganese hydrous oxide coatings, (3) complexation with organic substances bound or aggregated with particles, (4) incorporation into mineral lattices, organisms or fecal material, or (5) flocculation of collodal organic and inorganic matter during river and sea water mixing. The transport, accumulation and fate of such chemically reactive pollutants in coastal marine environments are governed to a great extent by particle dynamics. Understanding of the mechanisms and processes affecting pollutant-particle associations and dynamics allows the prediction of the fate of a wide variety of pollutants in estuarine, coastal, and marine environments.

POLLUTANT-PARTICLE DYNAMICS IN GEOCHEMICAL CYCLES

Olsen, C.R., Cutshall, N.H., Nelsen, T.A. (Oak Ridge National Lab., TN (USA)). 1982 Contract W-7405-ENG-26. 67p. NTIS, PC A04/MF A01. Order Number DE82009631. From NOAA workshop on pollutant transport by particles in the marine environment; Norfolk, VA, U.S.A. (19 Jan 1982).

A wide variety of substances, with known or potential pollutant capacity, are transported into the marine environment from the continents via river discharge, ocean dumping, or aeolian processes. Many of these substances are highly reactive and have a strong affinity for association with fine-grained particles. The movement of these reactive pollutants, their removal from the water, and their accumulation in the sediments are thus governed to a great extent by sedimentary processes. A review and overview of the biogeochemical aspects of pollutant-particle associations and dynamics is presented. (ACR)

SEDCON: A MODEL OF NUTRIENT AND HEAVY METAL LOSSES IN SUSPENDED SEDIMENT

Arizona Univ., Tucson, AZ, School of Renewable Natural Resources, W. A. Gabbert, P. F. Ffolliott, and W. O. Rasmussen.

In: Hydrology and Water Resources in Arizona and the Southwest, Proceedings of the 1982 Meetings of the Arizona Section—American Water Resources Assoc. and the Hydrology Section-Arizona Academy of Science, April 24, 1982, Vol. 12, p. 111-116. Ariz. Section, American Water Resources Assoc., Tempe. OWRT A-105-ARIZ(3), 14-34-0001-1103.

Descriptors: Water quality, *Nutrients, Hardness, *Mineral center, *Water resources management, *Watershed management, *Computer models, Model studies, *Heavy metals, Land management, *Sediment transport, Simulation analysis, Forest watersheds, SEDCON model, Southwest U. S.

A prototypical computer simulation model has been developed to aid watershed managers in estimating impacts of alternative land management practices on nutrient and heavy metal losses due to transported sediment on forested watersheds of the southwestern United States. The model, called SEDCON, allows users at remote locations with modest computer terminal equipment and commonly available data to obtain reliable estimates of nutrient and heavy metal concentrations in suspended sediment originating on uniformly-stocked, forested watersheds in the Southwest. SEDCON has been structured in an interactive mode to facilitate its use by persons not familiar with computer operations. Written in FORTRAN IV computer language, the model requires approximately 5000 words of core. SEDCON is operative on a DEC-10 computer at the University of Arizona.

W83-02734

SEDIMENT-WATER EXCHANGE IN SHALLOW WATER ESTUARINE SEDIMENTS

Washington Univ., Seattle School of Oceanography, S. Emerson, R. Jahnke, and D. Heggie.

Journal of Marine Research, Vol. 42, No. 3, p. 709-730, May, 1984. 7 Fig., 4 Tab, 40 Ref.

Descriptors: *Puget Sound, *Interstitial water, *Estuarine environment, *Fate of pollutants, *Sediments, Shallow water, Metals, Sediment-water interfaces.

Most reactive inorganic and organic pollutants that are introduced to the environment will, at some point in their journey to the sea, be buried or recycled within estuaries. Processes at the estuarine sediment-water interface play an important role in determining the ultimate fate of these substances. Pore water distributions are described in Quartermaster Harbor, Puget Sound over the period of 1976-1979 along with an in situ tracer experiment designed to monitor the transport of water across the sediment-water interface. Transport processes in sediment pores water of the Sound were dominated by molecular diffusion in the top few centimenters with animal activity being the most important transport process below this to 20-70 cm. The value of the transport parameter for the nonlocal process is 1 to 5 to the minu 7th power/second. Using this value and pore water concentrations it can be demonstrated that animal activities are the dominant process driving sediment-water dissolved fluxes except for elements with dramatic bottom water-pore water concentration gradients. For the metals Fe, Mn, Cu, Ni and Cd the dominant transport mechanism depends on the depth at which the metal is released to the pore waters. Probably the most important effect of biological activity on metal remobilization is the removal of sulfide from the pore waters, via ventilation of sediments with oxic overlying water, allowing the enrichment of dissolved metals which might otherwise be very low in concentration due to insoluble sulfide formation. The result is a greatly enhanced flux of metals to the bottom waters. (Baker-IVI)

W85-02473

SIGNIFICANCE AND BEHAVIOUR OF HEAVY METALS IN WASTE WATER TREATMENT PROCESSES: III SLUDGE TREATMENT AND DISPOSAL

Imperial Coll. of Science and Technology, London (England) Public Health Engineering Lab, J. N. Lester, R. M. Sterritt, and P. W. W. Kirk.

The Science of the Total Environment, Vol. 30, p. 43-83, September, 1983. 2 Fig., 16 Tab, 156 Ref.

Descriptors: *Sludge disposal, *Sludge treatment, *Heavy metals, Literature reviews, Anaerobic digestion, Land disposal, Toxicity, Chemical specification, Bioavailability, Groundwater pollution, Marine pollution, Legislation, Standards.

The literature concerning the significance and behavior of heavy metals in sewage sludge treatment and following sludge disposal is reviewed. Particular attention is given to metal form during anaerobic digestion and following sludge disposal to agricultural land and to sea, and the influence of metal form on toxicity. It is evident that anaerobic digestion results in a strong association between sludge particulates and heavy metals due to the formation of inorganic precipitates, organo-metallic interactions and by associations with the biomass. Toxic inhibition of anaerobic digestion by metals is concluded to be a direct result of the free metal ion concentration and thus mechanisms designed to reduce metal toxicity are based on artificial modification of heavy metal speciation in the digester. Guidelines and legislation designed to limit the application of sludge to agricultural and the disposal of sludge to sea are reviewed and discussed. Following the application of sludge to agricultural land significant changes occur in heavy metal speciation, which ultimately determine metal availability to plants and potential contamination of groundwaters. Guidelines for application to land currently take limited account of metal form, although the importance of metal specification is being recognized. Sludge disposal to sea has received relatively little attention with efforts being directed towards monitoring rather than more fundamental research. However, it is apparent that significant heavy metal solubilization may occur following sludge discharge to the marine environment. It is concluded that sludge disposal to agricultural land and sea, which are increasingly becoming subject to more stringent international pressures, should take account of the ultimate forms of heavy metals in the receiving environment and that a more unified approach should be adopted in the formulation of standards for all forms of sludge disposal. (Author's abstract)
W84-04748

SIGNIFICANCE AND BEHAVIOUR OF HEAVY METALS IN WASTE WATER TREATMENT PROCESSES; I SEWAGE TREATMENT AND EFFLUENT DISCHARGE

Imperial Coll. of Science and Technology, London (England), Public Health Engineering Lab, J. N. Lester.
The Science of the Total Environment, Vol. 30, p. 1-44, September, 1983, 8 Tab, 190 Ref.

Descriptors: *Heavy metals, *Wastewater treatment, Literature reviews, Biological wastewater treatment, Primary wastewater treatment, Sedimentation, Flocculation, Settling, Micro-organisms, Bacteria, Toxicity, Effluents, Water pollution effects, Water reuse.

The literature concerning the significance and behavior of heavy metals in waste waters is reviewed. Factors influencing the partition of heavy metals between the solid and liquid phases in both primary and secondary (biological) treatment are considered in detail. It is evident that during primary treatment only metals present in an insoluble form will be removed, but the removal of such forms is strongly influenced by the factors controlling sedimentation. During secondary treatment, metals initially present as soluble forms may be removed by association with the settleable biomass; further removal of insoluble metals also occurs by association with this biomass. Efficient flocculation and settling is critical to the removal of all metal forms during secondary treatment. Extracellular material, principally bacterial extracellular polymers, but also proteins and nucleic acids released as the result of cell lysis, appear to play a very significant role in the removal of soluble metals during secondary treatment. If biological treatment plants are overloaded with metals, toxic effects on bacteria and other micro-organisms may result in poor quality effluents; although the micro-organisms responsible for waste water treatment are able, within limits, to acclimatize to elevated metal concentrations. The impact of heavy metal contaminated effluents on receiving waters has also been reviewed and it is concluded that the most serious problem posed is drinking water production in areas where water reuse is practiced. (Author's abstract)
W84-04747

SIMULATION OF NUTRIENT AND HEAVY METAL TRANSPORT CAPACITY OF SUSPENDED SEDIMENT

Arizona Univ., Tucson, AZ, School of Renewable Natural Resources, W. A. Grabbert.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-125146, Price codes: A04 in paper copy, A01 in microfiche. M.S. Thesis, 1982. 49 p., 3 Fig., 9 Tab, 23 Ref, 2 Append. OWRT A-105-ARIZ.(1).

Descriptors: *Heavy metals, *Erosion Sediments, *Sediment Transport, *Sediment yield, *Nutrients, Chemical elements (metal), Stream erosion, Sediment production, Sedimentation, Sediment concentration, Watershed Management, Water Quality, Arizona, New Mexico, *Computer models, *Simulation analysis, *Forested watersheds.

Transport of nutrients and heavy metals by suspended sediments has commonly been ignored in studies of stream export from small watersheds. A prototypical computer simulation model was developed to aid watershed managers and land use planners in estimating the impact of alternative metal losses due to transported sediments on forested watersheds. Geology and vegetation of a watershed were used as predictors of chemical constituent concentrations in transported sediments. Predictive equations were developed using data collected in an earlier study, which found that differences exist in nutrient and heavy metal concentrations of sediments derived from various geologies and vegetation types. Combinations of vegetation types and geologies considered in this study include: ponderosa pine forest on soil parent material of bassalt, sandstone, granite or limestone, and mixed conifer forests on basalt.
W83-00609

SIMULATION OF NUTRIENT, MICROORGANISM AND HEAVY METAL TRANSPORT CAPACITY OF SUSPENDED SEDIMENT

Arizona Univ., Tucson, AZ, School of Renewable Natural Resources, P. F. Folliott and W. O. Rasmussen.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-248344, Price codes: A03 in paper copy, A01 in microfiche. Water Resources Research Center Completion Report, Tucson, AZ, August 1983. 23 p. 3 Fig., 4 Ref, 1 Append. OWRT A-105-ARIZ(4), 14-34-0001-1103.

Descriptors: *Erosion, *Sediments, Nutrients, Heavy metals, *Simulation model, Southwestern U. S., Microorganisms, *Computer programs, Prediction, Water quality control.

SEDCON, a computerized prediction technique (using vegetative and geologic data) which was developed to estimate land management impacts on the physical and chemical characteristics of transported suspended sediment in watersheds of the southwestern United States, is described. A hypothetical example is given to show that, after inputting experimental data or using the default values, estimated values of nutrient (acid digestible and extractable chemicals) and heavy transport capacities of suspended sediment and for (winter or summer) combinations of mixed conifer or ponderosa pine forests and basaltic, granitic, and sedimentary geologies can be displayed.
W83-03732

SORPTION OF CADMIUM BY MICROORGANISMS IN COMPETITION WITH OTHER SOIL CONSTITUENTS

Kurek, E.; Czaban, J.; Bolleg, J.M. (Pennsylvania State Univ., University Park). Applied and Environmental Microbiology; 43: No. 5, p. 1011-1015 (May 1982).

The fate of cadmium in soil is influenced to a great extent by microbial activity. Microorganisms were compared with abiotic soil components for their ability to sorb Cd from a liquid medium. When the same amount (on a dry weight basis) of bacterial cells (Serratia marcescens and Paracoccus sp.), clay (montmorillonite), or sand was separately incubated in 0.05 M phosphate buffer, ph 7.2, containing 10 ppm of Cd (10 μg/ml), bacterial cells removed the largest quantity of Cd. Dead cells sorbed much more Cd from the medium than live cells. A comparative study of Cd removal from the medium by seven soil bacteria and four fungi did not indicate appreciable differences. With increasing microbial biomass, the relative efficiency of 0.1 M NaOH as an extractant of sorbed Cd increased, whereas the extraction efficiency of 0.005 M DTPA (diethylenetriaminepentaacetic acid) decreased. It appeared that NaOH and DTPA extracted different chemical forms of Cd. This assumption was supported by vastly different correlation coefficients in the relative amount of Cd extracted by the two solvents.

STORM-SEWER INPUT OF HEAVY METALS INTO AN URBAN LAKE ENVIRONMENT

Duba, G. A., Kalamazoo, MI, Western Michigan Univ. (1981). 131 p. University Microfilms Order No. 81-17,698. Thesis (Ph.D.).

The purpose of this study was to measure the concentration of lead, cadmium, zinc and copper in runoff entering an urban lake ecosystem and to measure the distribution of these metals in selected tropic levels of the lake. Fisk Lake was chosen as the study site and is located in East Grand Rapids, Michigan. Samples were collected of stormwater, rainwater and lakewater together with substrate, aquatic macrophytes, chironomid larvae, snails, and eight species of fish. All samples were collected on the basis of being close to or distant from, a storm sewer contaminated portion of the lake. Samples were prepared and analyzed using atomic absorption spectrophotometry (AA) and particle induced x-ray analysis (PIXE). The results of this study suggested that: (1) The metals did not show highest concentrations at highest tropic levels; (2) lead, zinc and copper were detected in stormwater; (3) although some substrate was highly contaminated, the other tropic levels need not show similar contamination; and (4) the benthic organisms, although shown to contain elevated metal levels, do not seem to be passing these concentrations along the food chain.

THE ABUNDANCE OF AU, PT, PD, AND THE MODE OF HEAVY METAL FIXATION IN HIGHLY POLLUTED SEDIMENTS FROM THE RHINE RIVER NEAR MAINZ, WEST GERMANY

Mainz Univ. (Germany, F.R.), C. B. Dissanayake, K. Kritsotakis, and H. J. Tobschall.
International Journal of Environmental Studies, Vol. 22, No. 2, p. 109-119, January, 1984. 4 Fig., 3 Tab, 28 Ref. Deutsche Forschungsgemeinschaft grant 53/11.

Descriptors: *Heavy metals, *Pollutants, *Sediments, *Rhine River, *Mainz, *West Germany, *Gold, *Lead, *Platinum, *Ginsheimer-Altrhine River, Fate of pollutants, Industrial wastes, Water pollution, Pollution load.

The Au, Pt, and Pd contents of the sediments of Ginsheimer-Altrhine River, a channel of the Rhine river which drains one of the most industrialized regions of western Europe, have been determined by flameless atomic absorption spectrophotometry. The abundances of these noble metals range from 96-460 ppb Au; 734 ppb-31 ppm Pt and 32 ppb-4 ppm pD. The extremely high concentrations, particularly those of Pt and Pd, are attributed to their use in industry and are due to the formation and concentration of metal-organic complexes, mainly at the interface between an extremely reducing and an oxidizing aquatic environment. Differential thermal analyses of the polluted sediments in comparison to the pure humic acid and Fe-humate complex show that humic and fulvic acids are of great importance in the transport of heavy metals in polluted stream sediments. (Author's abstract)
W84-04662

THE MOVEMENT OF METALS APPLIED TO SOILS IN SEWAGE EFFLUENT

Texas A and M Univ., College Station, TX, Dept. of Soil and Crop Sciences, K. W. Brown, J. C. Thomas, and J. F. Slowey.

Water, Air, and Soil Pollution, Vol. 19, No. 1, p. 43-54, 1983. 5 Fig., 2 Tab, 29 Ref.

Descriptors: *Heavy metals, *Land disposal, *Sewage disposal, Erosion, Permeability, Leaching, Soil types, Water pollution sources, Land management.

The fate of five heavy metals when applied to four diverse soils in secondary treated sewage effluent was examined. Spiking of the samples was done to simulate long term metal additions from effluents low in total metals. The sewage effluent had a mean BOD of 7.6 mg/l, a mean total organic carbon of 34.4 mg/l and a pH of 7.8. It was spiked with sulfates of Cd, Cu, Ni, and Zn and the nitrate of Pb to concentrations which averaged 0.82, 0.83, 0.75, 0.91, and 0.74mg/l of each metal, respectively. The soils used were Bastrop, a udic paleustalf; Lakeland, a typic quartzipsamment; Nacogdoches, a rhodic paleudalf; and Norwood, a typic udifluvent. Subsamples of the leachate water were collected monthly from all lysimeters throughout the study to determine if any of the metals moved from the soil profiles. Results indicated that while the metals did move in the soil, none entered the leachate collected 150 cm below the surface during this study. Thus even highly permeable soils such as the Lakeland were able to retain the metals applied in sewage effluent and decrease the potential for movement in the groundwater. Since the metals did accumulate in the surface soil, good land management techniques will be needed to minimize the movement of metals via soil erosion. (Baker-FRC)
W84-00429

THE ROLE OF DELAWARE RIVER FRESHWATER TIDAL WETLANDS IN THE RETENTION OF NUTRIENTS AND HEAVY METALS

Simpson, R. L. (Rider Coll., Lawrenceville, NJ); Good, R.E.; Walker, R; Frasco, B.R. *Journal of Environmental Quality*; 12: No. 1, 41-48 (Jan 1983).

Tidal cycle budgets for June, July, August, September, and November 1979 showed that inorganic N was imported to the wetland from the Delaware River early in the growing season and exported late in the growing season. Nitrate and organic nitrogen were imported following macrophyte dieback. Reactive P was never lost from the marsh, and was actually imported on three dates. Total P was imported in July, September, and November, but otherwise exported. The metal present in the lowest concentration, Cd, was always exported; Ni, Cu, Zn were imported on all but one date. Lead was imported late in the growing season and following macrophyte dieback. Nonpoint-source inputs of Pb exceeded inputs from tidal waters. The vegetation played a major role in the retention of N, P, Cu, Pb, and Ni entering the wetland through the growing season. The litter retained significant quantities of all heavy metals following macrophyte dieback, but it serves only as a temporary storage vehicle because rates of decomposition are high. The soil showed no definite seasonal pattern of nutrient or heavy metal retention. Elevated Pb levels occurred at sites near storm drains reflecting rapid sedimentation and retention of this metal as storm waters entered the wetland. It is concluded that freshwater tidal wetlands play an important seasonal role in reducing nutrient and heavy metal loading in the upper Delaware River estuary.

THE ROLE OF FULYIC SUBSTANCES ON TRACE METAL PARTITIONING IN NATURAL AQUATIC SEDIMENTS

Massachusetts Univ., Amherst, Dept. of Chemistry, O. T. Zajicek.

Available from the National Technical Information Service, Springfield, VA 22161 as PB83-222844, Price codes: A03 in paper copy, A01 in microfiche. Water Resources Research Center Publication No. 140, Massachusetts University, Amherst, May 1983. 38 p., 13 Fig., 2 Tab, 12 Ref. OWRT A-127-MASS(1), 14-34-0001-0123

Descriptors: *Hydrogen ion concentrations, Solubility, *Fulvic acids, Sediments, *Metals, *Carbonates, Carbonate rocks, *Soil chemical properties, Aquatic soils, Adsorption, Acidity, Alkalinity, Chemical precipitation, *Potentiometers, Cadmium, Copper, Iron, Manganese, Zinc, Oxides, Silica, Titration, *Volumetric analyses.

The effect of fulvic acids (1) on the solubility of the metal carbonates of copper, cadmium, manganese, and zinc, (2) on the adsorption properties of silica and pyrolusite; and (3) on the acid attack on ferric orthophate were investigated by means of distribution and potentiometric measurements. Metal carbonates were found to increase in solubility in waters containing fulvic acids proportional to the fulvic acid concentrations. Metal concentrations obtained exceeded acceptable limits for aquatic systems. Metal ion adsorption on SiO sub 2 and MnO sub 2 was essentially unaffected by pH over range 5-9. The addition of fulvic acids resulted in the desorption of the majority of the metal from SiO sub 2, and to a much lesser extent, MnO sub 2. Ferric orthophosphate, FePO sub 4, was found to form in solutions of low pH. Formation of ferric oxide occurred at higher pH values than usual in the presence of phosphate and fulvic acids. The fulvic acids appear to enhance solubilization processes by complexation of metal ions in solution. They aid or hinder the adsorption of metals on hydrous metal oxides, depending upon the relationship between the pH and the point of zero charge of the oxide substrate. Adsorption on silica is markedly affected by fulvic acids, and that on pyrolusite by both fulvic acids and pH.
W83-03348

TRACE ELEMENT DETERMINATION IN SUSPENDED PARTICULATE MATTER FROM NATURAL WATERS BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS: EVALUATION OF THE METHOD

Boniforti, R; Madaro, M; Moauro, A. (Comitato Nazionale per l'Energia Nuclear, Casaccia (Italy). Dipartimento Tecnologie Intersettoriali di Base). 1982. 25 p. NTIS (US Sales Only), PC A02/MF A01. Order Number DE83901786.

Portions are illegible in microfiche products.

This paper presents results obtained by measuring trace elements in particulate matter collected from natural waters (gulf of La Spezia, Vara and Magra rivers), using instrumental neutron activation analysis and P-spectrometry. Precision and accuracy of the procedure and the detection limits in the experimental conditions used have been evaluated. 21 elements (As, Au, Ba, Ce, Co, Cr, Cs, Eu, Fe, Hf, Hg, La, Lu, Mn, Rb, Sb, Sc, Sm, Th, Yb, Zn) were determined. This work has shown that samples of natural waters taken at the same place consecutively can exhibit a very high variability in trace element content.

TRACE METALS IN SEDIMENTS OF THE ST. JONES AND MURDERKILL RIVERS, DELAWARE

Delaware Univ., Newark. Coll. of Marine Studies, D. Hoffman and R. Biggs.

Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111897, Price codes: A02 in paper copy, A01 in microfiche. Water Resources Center Completion Report, September, 1983. 14 p., 2 Fig., 4 Tab, 2 Ref. OWRT A-055-DEL(1), 14-34-0001-2108.

Descriptors: *Trace metals, *Sediments, *Estuaries, *Delaware, Water chemistry, St. Jones River, Murderkill River, Copper, Cadmium, Zinc, Chromium, Iron, Lead, Manganese, Pollutant identification, Water pollution sources.

The metals Cu, Cd, Cr, Zn, Fe, Mn, Pb were analyzed from surface sediments from 47 locations into the Murderkill and St. Jones Rivers, Delaware. Prior to 1976, the St. Jones received domestic sewage from the City of Dover, Delaware. A regional sewage plant began operations in 1976 and discharged the combined wastes from Dover and surrounding areas in the Murderkill. Results of the 1982 metals survey were compared with data obtained by the same authors at the same locations in 1973. Cu, Cd, and Pb show higher concentrations in Murderkill bed sediments in 1982 than in 1973. These concentrations decrease in the mainstream rive away from the STP discharge points. Cr, Fe, and Mg do not show such excursions and are indistinguishable from the 1973 concentrations. Metal concentrations in bed sediments of the St. Jones River show no change for 1973 to 1980, except that Pb, Cd and Zn sediment concentrations are generally lower in 1982. The analyses suggest that Cu, Cd, and Pb are increasing in the sediments from the Murderkill while Fe, Mn, and Cr are not. Pb, Cd, and Zn are decreasing in the St. Jones sediments, perhaps because they are being leached from the sediments or because they are being buried and diluted with clean materials.
W84-00049

TRANSPORT OF HEAVY METALS ON SUSPENDED SEDIMENTS UNDER HIGH FLOW CONDITIONS IN A MINERALIZED REGION OF WALES

University Coll. of Wales, Aberystwyth, Dept. of Geography, S. B. Bradley and J. Lewin.

Environmental Pollution, Series B, Vol. 4, No 4, p. 257-267, 1982. 5 Fig., 2 Tab, 22 Ref.

Descriptors: *Metals, *Sediment transport, *Floods, Fate of Pollutants, *Mine wastes, Heavy metals, Lead, Zinc, Cadmium, Iron, Sulfur, Phosphorus, Suspended sediments, Ystwyth River, *Wales, Chemical precipitation, Absorption, High flow.

Concentrations of PB, Zn, Cd, Fe, S and P on the surface of suspended sediments in the River Ystwyth, Wales, were determined over a 40 hour flood period June 1 to 3, 1981. Pb and Zn are supplied to the river by abandoned mines. During this flood the discharge peaked at 16 cumecs, 6 hours after the peak suspended sediment concentration of 70 mg per liter. Generally, the metals concentrations on the sediment surface decreased as discharge increased, due to dilution with clean sediment. On the falling limb of the hydrograph, sorption and coprecipitation by Fe/Mn complexes acted as a sink for the metals. The correlation of Pb and Zn levels with P and S levels suggests the formation of Pb and Zn phosphates and sulfides on the sediment surface. Total Pb and Cd on the sediment surface being transported was greatest during higher discharges, but total Zn transport was lower during high discharge, reaching a peak immediately after the discharge peak. (Cassar-FRC)
W83-03048

NUTRIENTS

ADSORPTION OF PHOSPHATE, ARSENATE, METHANEARSONATE, AND CACODYLATE BY LAKE AND STREAM SEDIMENTS: COMPARISONS WITH SOILS

Agricultural Research Service, Stoneville, MS, Southern Weed Science Lab, R. D. Wauchope and L. L. McDowell. Journal of Environmental Quality, Vol. 13, No. 3, p. 499-504, July-September, 1984. 3 Fig., 5 Tab, 29 Ref.

Descriptors: *Adsorption, *Lake sediments, *Stream sediments, *Methanearsonate, *Cacodylate, *Phosphates, *Arsenates, Agricultural chemicals, Soil types, Soil properties, Mississippi River flood plain, Clay, Iron, Aluminum, Fate of pollutants.

The sorption characteristics were measured of 14 lake sediments collected in the Delta Mississippi River flood plain for arsenate, phosphate, methanearsonate, and cacodylate. In runoff and stream flow the concentrations of dissolved P and arsenic are each typically < 1 mg/L in a well oxygenated, mixed sediment water flow. To simulate runoff stream mixing dilute sediment mixtures spiked with the compounds to give 50 and 500 micro g/L As or P were used. For comparison with field soils from the same area the Bache-Williams index procedure was used. The results allow comparsion of soils and sediments for sorption of these chemicals and provide insight into the relative ability of these sediments to act as sinks for runoff arsenicals and phosphate. In general, if the higher range of clay and hydrous oxides contents of these sediments are taken into account, their adsorptive capacity for phosphate, arsenate, methanearsonate, and cacodylate could be predicted from the trends found earlier for soils. Clay content remains the best single predictor of arsenical adsorption whether in field soils or in dilute water-sediment mixtures. Phosphate fixation at high P conditions is more specific for Fe and Al. Under dilute slurry conditions, P may adsorb or desorb depending on P added and P already in the sediment, but the amount Fe/Al/clay content will determine the degree to which a sediment can act as source or sink. For these Mississippi Delta sediments, those with high clay content had a very large unfilled capacity to act as P or arsenical sinks. (Baker-IVI)
W85-01297

ALGAL AVAILABILITY OF PHOSPHORUS IN SUSPENDED STREAM SEDIMENTS OF VARYING PARTICLE SIZE

Purdue Univ., Lafayette, IN, Dept. of Agronomy, R. A. Dorich, D. W. Nelson, and L. E. Sommers. Journal of Environmental Quality, Vol. 13, No. 1, p. 82-86, 1984. 4 Tab, 23 Ref. EPA grant G00533501.

Descriptors: *Algae, *Phosphorus, *Streams, *Suspended sediments, *Particle size, Agricultural watersheds, Inorganic phosphorus, Eutrophication, Bioassay, Algal growth.

Phosphorus limits algal growth in many aquatic systems and inputs of P into such systems have caused algal blooms and associated water quality problems. The availability of sediment P to algae was evaluated in several water stable aggregate-size fractions of suspended stream sediments collected from an agricultural watershed in northeastern Indiana. Sediments were collected during a storm event, separated into the < 2, 2 to 20, 20 to 53, 53 to 212, and 212 microm size fractions, sterilized by gamma irradiation, and incubated for 2 weeks with algae. Algal-available P (Paa) was determined by measuring decreases in the NaOH- and HCl-extractable inorganic P (Pi) fractions in sediment during the incubation period. The initial concentrations of P in the NaOH- and HCl-extractable Pi fractions were not related to aggregate size. All aggregate-size fractions had similar Paa concentrations. Nearly equal proportions of sediment Pi (avg 79%) and total P (avg 43%) in aggregate fractions were available to algae, possible resulting from the similar distribution of primary particle sizes in all aggregate-size fractions. More than 93% of Paa originated in the NaOH-extractable P fraction. Samples that were affected by septic effluents tended to be higher in certain sediment P parameters (e.g., NaOH-extractable Pi, total Pi, total P, and Paa concentrations) than samples containing suspended sediment derived from cropland. This study suggests that runoff models may not need to account for the detachment and transport of aggregate-size classes to predict the movement of algal-available P from cropland to surface waters. (Murphy-IVI)
W84-03939

ALGAL-AVAILABILITY OF PARTICULATE PHOSPHORUS FROM DIFFUSE AND POINT SOURCES IN THE LOWER GREAT LAKES BASIN

Clarkson Coll. of Technology, Potsdam, NY, Dept. of Civil of Environmental Engineering.
T. C. Young and J. V. DePinto. Hydrobiologia, Vol. 91, p. 111-119, July, 1982. 6 Fig., 5 Tab, 24 Ref. EPA grant R-806817-01.

Descriptors: *Phosphorus, *Great Lakes, *Algal growth, *Algae, Phytoplankton, Productivity, Aquatic productivity, Nutrients, Bioassay, Wastewater treatment.

Control of phytoplankton production in the Great Lakes can be achieved most efficiently by limiting inputs of biologically available P. We report the results of studies performed to characterize the chemical forms and availability of particulate P in wastewater and tributaries which enter the lower Lakes, the eroding bluffs which border Lake Erie, and bottom samples from the near-shore of western Lake Erie. Rates of release of available P were estimated from a simple first-order model of the process, as observed during algal bioassays. Available P in wastewater samples, as a fraction of total particulate P, was affected minimally by wastewater treatment, including chemical precipitation

and filtration; it correlated well with levels of total particulate P. Available particulate P levels in fluvial suspended sediments showed regional uniformity, but appeared to be strongly dependent of levels of both NaOH-P and CDB-P. Rates of release of available P decreased during wastewater treatment to values which were similar in magnitude to those observed for fluvial sediments. Release rates, however, were not related to any of the particulate P fractions which were measured. Analysis of the bluff and bottom samples indicated that P availability in the former was negligible, but the latter contained levels which approached those of wastewater particulates, though available P was released from the bottom sediments at relatively low rates. (Author's abstracts)
W85-02061

AN EXAMINATION OF LAND USE—NUTRIENT EXPORT RELATIONSHIPS

Kentucky Natural Resources and Environmental Protection Cabinet, Frankfurt, Div. of Water, M. N. Beaulac and K. H. Reckhow.

Water Resources Bulletin, Vol. 18, No. 6, p. 1013-1024, December, 1982. 6 Fig., 2 Tab, 75 Ref.

Descriptors: *Land use, *Nutrients, *Nonpoint pollution sources, Fate of pollutants, Water pollution sources, Forest watersheds, Agricultural watersheds, Urban watersheds, Nitrogen, Phosphorus, Runoff, Climates, Fertilizers, Soil types, Farm wastes, Farm management, Pastures, Feedlots, Manure, Reviews, Watershed management.

A literature review of nutrient export studies relates land use to fluxes of phosphorus and nitrogen. The magnitude of nutrient flux is influenced by land use (considered here are forest, agricultural, and urban watersheds) in general and by soils, climate, and land cover management practices in particular. Nutrient export from forest land is low and homeostatic: from urban watersheds high and widely variable. In forest land, higher nutrient loads result from hardwood watershed than from softwood watersheds, from loams and sedimentary formations rather than sand overlying granites, and from glaciated regions. Nutrient flux is greater in warm humid climates than in drier climates. In agricultural lands the factors promoting high nutrient loads are fallow land, clay or organic soils, application of fertilizers before or during high runoff periods, over- or under-fertilization, row cropping, poor infiltration, high farm animal density, lack of detection basins, and a greater proportion of nitrogen-fixing crops. Sources of nutrients in urban areas are impervious surfaces, atmospheric emissions, deicing chemicals, street dirt, construction site erosion, industrial spills, and illegal wastewater discharges. As watersheds become increasingly removed from the natural state and the degree of human pertubation increases, the ability to predict the interactions between land use and response of water bodies becomes less precise and more difficult. (Cassar-FRC)
W83-03144

AN INSTITUTIONAL PERSPECTIVE ON THE USE OF NATURAL RESOURCES AND THE IRRIGATION AND NITRATE CONTAMINATION PROBLEM

Wisconsin Univ. Madison, WI, Dept. of Agricultural Economics, D. W. Bromley and R. C. Griffin.

Available from the National Technical Information Service, Springfield, VA 22161 as PB83-235218, Price codes: A04 in paper copy, A01 in microfiche. Water Resources Center Publications No. WIS WRC 83-6, Univ. of Wisconsin, Madison, 1983. 49 p., 2 Fig., 1 Tab, 78 Ref. OWRT A-085-WIS(1), 14-34-0001-0153.

Descriptors: *Agricultural runoff, *Economic aspects, *Irrigation, *Natural Resources, *Nonpoint pollution sources, Agricultural chemicals, Beneficial use, *Nitrates, Policy making, *Wisconsin, Central Sands area.

Cognizance of the nonpoint nature of many forms of agricultural pollution renders traditional pollution policies depend on the ability to identify the individual externality contributions of each economic agent. This fact has clouded the search for economically efficient programs for confronting instances of agricultural pollution and may have led to the institution of policies without sufficient attention to economic consequences. Discussions are provided of the consequences not including relationships or models performing as nonpoint production functions in economic analyses of agricultural runoff. It was noted that the Universal Soil Loss Equation has been used to obtain simultaneous economic and environmental modeling, but some deficencies in this type of analysis are still present. Present policy for agricultural runoff focuses on the concept of "best management policies," but several failures of this policy have been isolated. A second section of this report deals with fundamental economic questions of natural resources use, namely, who controls the institutions that allocate natural resources, who receives the benefits from particular use patterns and who is exposed to the costs arising from the use of natural resources. The third portion of the report is a lay-person's discussion of the impacts of irrigation on nitrate contamination problem. The site of the study is the Central Sands area of Wisconsin. An outline is provided of the options of policy makers for solving this problem together with a discussion of the ramification of each option.
W83-03587

ANALYSIS OF TOTAL PHOSPHORUS TRANSPORT IN RIVER SYSTEMS

West Virginia Univ., Morgantown, WV, F. H. Verhoff, D. A. Melfi, and S. M. Yaksich.

Hydrobiologia, Vol. 91, p. 241-252, July, 1982. 11 Fig., 8 Ref.

Descriptors: *Phosphorus, *Solute transport, *Path of pollutants, Sediment transport, Storm water, Nutrient transport, Nitrogen.

Human activities generate many pollutants from different land uses. These pollutants include nutrients (e.g., phosphorus and nitrogen), toxic substances (e.g., heavy metals and pesticides), and other substances (e.g., chlorides and salts). These materials often enter a river at some upstream point and are transported downstream by the flowing water. Many substances are transported both during storms and during normal river flow and often the major portion of the transport occurs during the storm. This paper considers the quantification of transport primarily during storms. First, the characteristics of storm transport are discussed. Then, a calculation method for estimating the distance of travel for sediment related materials is presented. Third, a technique to estimate the amount of a given chemical passing a point in a stream over a specified period of time is presented. The last part of this paper contains a technique for tracing the movement of substances through a river network. In particular, this procedure yields information as to the source of given pollutants over the entire storm period. (Author's abstract)
W85-02074

BIOAVAILABILITY OF PHOSPHORUS INPUTS TO LAKES

National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab, W. C. Sonzogni, S. C. Chapra, D. E. Armstrong, and T. J. Logan.

Journal of Environmental Quality, Vol. 11, No. 4, p. 555-563, October-December, 1982. 2 Fig., 2 Tab, 16 Ref.

Descriptors: *Phosphorus, *Eutrophication, *Lakes, Phosphates, Water pollution sources, Fate of pollutants, Reviews, Algae, Sediment, Adsorption, Desorption, Water quality management, Agricultural runoff, Suspended sediments, Pollutant identification.

Current information on the bioavailability of forms of phosphorus delivered to lakes from different sources is reviewed with attention to management implications. Dissolved P is readily available for use by algae and higher plants, either directly (inorganic P) or readily convertile (condensed P and organic P). Particulate P is partially available for biological use in the inorganic form (nonapatite inorganic P) and convertile to dissolved reactive P in the organic and condensed forms. Inorganic P in the apatite inorganic form is essentially unavailable. Methods of analyzing for bioavailable inorganic P are described. Potentially available P corresponds with the dissolved reactive P (DRP) plus the fraction of particulate inorganic P obtained by extraction with 0.1 NaOH. Natural factors influencing bioavailability include the rate of P release from suspended particles, the rate of settling of suspended particles, the equilibrium concentration of DRP, algal uptake, and phosphate desorption rates. Potential bioavailability has been estimated at 20-80% of total P input, usually in the lower part of the range P sources include agricultural and urban runoff, water and wind erosion, fertilizers, atmospheric deposition, and wastewater effluents. Management programs for lakes should consider bioavailability of P to avoid costly overcontrol of P inputs. Most efficient P management should attack the sources highest in DRP; municipal point discharges and excessive fertilizer application. (Cassar-FRC)
W84-00336

BIOLOGICAL AVAILABILITY OF SOLUBLE REACTIVE PHOSPHORUS IN ANOXIC AND OXIC FRESHWATERS

McGill Univ., Montreal (Quebec), Dept. of Biology, G. Nurnberg and R. H. Peters.

Canadian Journal of Fisheries and Aquatic Sciences, Vol. 41, No. 5, p. 757-765, May, 1984. 3 Fig., 5 Tab, 32 Ref.

Descriptors: *Phosphorus, *Hypolimnion, *Bioavailability, Phosphates, Lakes, Sediment, Chemical reactions, Anoxic conditions, Aeration, Hypolimnion.

The equivalence of soluble reactive phosphorus (SRP) and biologically available phosphorus (BAP) was investigated. The experimental work is largely confined to anoxic lake water from hypolimnia and cores containing phosphorus released from the sediment. The short-term radiological bioassays used measured BAP and were specific for phosphate and kinetically similar substances. To cover a large range of phosphorus concentrations, water bodies, and techniques, a comparison was also made of published concentrations of SRP with BAP or phosphate. In the anoxic hypolimnia of 8 lakes and in anoxic model systems (core tubes) at least 80% of soluble reactive phosphorus is biologically available. Biologically available phosphorus is only a small fraction of soluble reactive phosphorus in iron-rich, previously anoxic waters after aeration and in lake water from the anoxicoxic interface. This result is supported by published data for oxic waters from epilimnia of lakes, rivers, sewage effluent, and precipitation. (Baker-IVI)
W86-00803

CAN WE SAVE THE CHESAPEAKE BAY

C. Joyce, New Scientist, Vol. 97, No. 1350, p. 797-800, 24 March, 1983, 4 Fig.

Descriptors: *Estuaries, *Water pollution effects, *Environmental effects, *Chesapeake Bay, Nutrients, Nitrogen, Phosphorus, Acid rain, Bays, Aquatic life.

In efforts to stop the disappearance of anadromous fish, crab, oyster, and plant life in the Chesapeake Bay area, a study was undertaken which divided the Bay into geographical units but kept in mind the fact that each of these units works with the others in the total ecosystem picture. These units included the tidal freshwaters at the heads of any of the dendritic tributaries that feed the bay, and the turbidity-maximum area where circular currents raise a curtain of sediments and living things. Human influence has been cited as the largest of the causes of the bay's ills. The ever increasing supply of nutrients in the estuary is possibly the major cause behind the thickening of the bay's

waters. Scores of sewage plants along the Chesapeake's tributaries are disgorging nitrogen and phosphorus, natural products of biological sewage treatment. Nitrogen comes in large part from the runoff of fertilizers. In the future, however, current findings indicate that atmospheric deposition of nitrogen especially as nitrate may well overtake deposition from land runoff. (Baker-IVI)
W84-02012

CARBON, NITROGEN, AND PHOSPHORUS TRANSPORT BY WORLD RIVERS

Ecole Normale Supericure, Paris (France) Lab. de Geologie, M. Meybeck.

American Journal of Science, Vol. 282, No. 4, p. 401-450, April, 1982. 8 Fig., 11 Tab, 134 Ref.

Descriptors: *Rivers, *Cycling nutrients, *Nitrogen, *Phosphorus, *Carbon, Organic carbon, Dissolved solids, Precipitation, Water pollution sources, Fate of pollutants.

The various forms (dissolved and particulate, organic and inorganic) of carbon, nitrogen, and phosphorus in world rivers are reviewed. Specific topics of discussion include basic data and procedures used in river transport budgets; computation methods used in budgets, such as the use of simple extrapolation, typology, support parameters, use of small representative watersheds, and the direct estimate of additional inputs due to man's activities; and the origin of basic data. Major findings on organic carbon, nitrogen, and phosphorus levels and loads in rivers are described. World average concentrations and river loads of the various C, N, and P forms are listed tabularly. The influence of man's activity on river nutrient transport has been studied through comparisons of neighboring watersheds, the evolution with time of nutrient level in representative rivers since the beginning of intensive agriculture and the industrial era, and direct measurements of various pollutant sources such as urban wastes, discharges, and agricultural runoff. Results are presented from studies dealing primarily with the evolution approach to measurement. Rivers are a major link between continents and oceans. They can be considered from one viewpoint as an output of terrestrial ecosystems and land erosion processes, and from the other viewpoint as an input to the ocean systems. These two viewpoints are considered together with the modification of the transfer rates resulting from man's activities. (Baker-IVI)
W85-01299

COMPARISON OF A SIMPLE AND A COMPLEX SEDIMENT PHOSPHORUS MODEL

S. E. Jorgensen, L. Kamp-Nielsen, and H. F. Mejer.

Ecological Modeling, Vol. 16, No. 2/3/4, p. 99-124, August, 1982, 3 Fig., 1 Tab, 22 Ref.

Descriptors: *Lake sediments, *Model studies, *Phosphorus, Lake Esrom, Oxygen, Mathematical equations, Decomposition, Diffusion, Adsorption, Sedimentation, Resuspension.

A model describing phosphorus and oxygen conditions in lake sediments is presented as a set of partial differential equations. The mechanisms included are anaerobic and aerobic decomposition, diffusion, adsorption, chemosorption, sedimentation and resuspension. The decomposition process takes into account that effective age profiles are influenced by oxygen and temperature conditions. The driving variables and comparisons with measurements are based on experimental data from Lake Esrom. A comparison is made between these results and those obtained using a simple model. The more complex model does not fit the observed values any better than does the simpler except in the case where an additional process is incorporated, grazing at the sediment surface. The complex model has been used to relate the empirical parameters in the simpler model to generally applied concepts such as diffusion coefficients, the thickness of the transition layer, the sediment compaction and the annual net sedimentation. (Baker-IVI)
W85-01303

COMPARISON OF PRECIPITATION AND LAND RUNOFF AS SOURCES OF ESTUARINE NITROGEN

Smithsonian Institution, Edgewater, MD, Chesapeake Bay Center for Environmental Studies, D. L. Correll and D. Ford.

Estuarine, Coastal and Shelf Science, Vol. 15, No. 1, p. 45-56, July, 1982. 8 Fig, 3 Tab, 16 Ref. NSF Grant No. DEB-79-11563, EPA Grant No. R-804536.

Descriptors: *Water pollution sources, *Nitrogen, *Estuaries, *Precipitation, *Runoff, Air pollution, Fallout, Agriculture, Fertilizers, Ammonia, Amines, Nitrates, Chesapeake Bay, Atlantic Coastal Plain.

Seasonal and year to year variation of bulk precipitation as a source of total N, nitrate and ammonia is reported for a 7 year period at the Rhode River, a subestuary of Chesapeake Bay. These values are placed in perspective by comparison with analogous nitrogen loading due to watershed discharges. A significant amount of the variance in nitrogen area yield loading due to precipitation can be explained by covariance in rainfall volume. Variation in the amount of spring rain would account for 50% of the variation in spring nitrate area loadings. Average area loading rates for nitrate, ammonia, TKN and total N were all highest in the spring followed by the summer. Nitrate precipitation area loadings were almost twice those for ammonia. Dissolved ammonia was only determined for 3.5 years but usually accounted for about one third to one half of the TKN in bulk precipitation. Trend analyses of the pH of bulk precipitation have indicated a general decline in pH from 1974 to 1980, particularly in spring and summer seasonal data. While year to year variations were important, in an average year about the same amount of readily available nitrogen entered the system via precipitation as entered in land runoff and, during the summer and fall, precipitation was the largest source. (Baker-IVI)
W85-00649

CONTROL OPTIONS FOR NITRATES AND FLUORIDES

Black and Veatch, Dallas, TX, W. J. O'Brien. Water Engineering and Management, Vol. 130, No. 7, p. 36-38, 51, July, 1983. 4 Fig., 4 Tab, 7 Ref.

Descriptors: *Nitrates, *Fluorides, *Drinking water, Water quality, Standards, Public health.

Nitrate and fluoride concentrations in drinking water supplies must be controlled for sound public health reasons, primarily for the protection of two population groups—infants and children up to the age of 14, respectively. Water containing concentrations of nitrate nitrogen greater than 10 mg/l has been known to produce a disorder known as methemoglobinemia in infants less than three months old. Fluoride controls are in force to prevent dental fluorosis, a discoloration or mottling that occurs when teeth are being formed. Strong base anion exchange resins have usually been the preferred method for removing nitrate from water supplies. The major problem is a fouling of the resin when ferrous iron is present in the raw water. Presently it is not economical to use anion exchange resins for removal of fluoride as resins exhibit no selectively for this element. Excess lime softening is frequently used and the amount of fluoride that can be removed by this method is proportional to the quantity of magnesium in the water. (Baker-IVI)

W84-01915

DETERMINATION OF ALGAL-AVAILABLE PHOSPHORUS ON SOIL AND SEDIMENT: A REVIEW AND ANALYSIS

Pennsylvania Univ., Philadelphia, PA Dept. of Civil and Urban Engineering, L. A. Hegemann, A. H. Johnson, and J. D. Keenan.

Journal of Environmental Quality, Vol. 12, No. 1, p. 12-16, January/March, 1983. 63 Ref.

Descriptors: *Sediments, *Phosphorus, *Algae, Reviews, Soil, Nutrients, Bioassay, Agricultural runoff, Phosphates, Fate of pollutants, Lake sediments, Bottom sediments.

Recent research on algal-available phosphorus associated with soil and sediments is reviewed. The bioassay and chemical fractionation procedures were nonuniform and involved site-specific soils, making quantitative comparisons difficult. Many studies showed that some of the Fe- and Al-bound P is available to algae in bioassays. However, it has not been shown that all the P extracted from the non-apatite fraction is algal-available. Stable organic P in soils and sediments appears to be of very limited availability, depending on environmental conditions and the degree of bacterial action, which liberates orthophosphate. It is reported that from 0 to 80% of total soil P is available to algae. The short-term batch culture assays most likely do not identify the total quantity of algal-available P. Longer-term experiments (longer than 100 days) would probably give more accurate results. (Cassar-FRC)

W83-03979

EROSION OF SOIL AND POULTRY MANURE—A LABORATORY STUDY

North Carolina State Univ. at Raleigh, NC, Dept. of Biological and Agricultural Engineering, P. W. Westerman, T. L. Donnelly, and M. R. Overcash.

Transactions of the American Society of Agricultural Engineers, Vol. 26, No. 4, p. 1070-1078 and 1084, July-August, 1983. 1 Fig., 12 Tab, 45 Ref.

Descriptors: *Manure, *Soil erosion, *Path of pollutants, Water pollution sources, Farm waters, Land application, Rainfall intensity, Sediment transport, Loading rate, Waste disposal.

Land application of livestock and poultry manures on bare soil can result in high availability of nutrients for transport in surface runoff which may result in pollution of streams, rivers, and lakes. Farmers often wait several days after manure application before they incorporate the manure. The transport of soil and manure by simulated rainfall on 1 m x 0.64 m laboratory test plots was investigated to determine the effects of rainfall intensity, soil type, manure type, loading rate and drying time. A factorial experimental design was used with each factor at two levels. Rainfall intensity and soil type were significant factors for solids transport, and manure loading rate was a significant factor for nutrient transport. Loading rain strongly influenced volatile solids, manure solids and nutrient transport. Manure type and drying time were also significant factors for transport of certain nutrients. Increased drying time reduced manure and soil transport. Several factors and their interactions had significant effects on erosion and transport of soil, manure and nutrients. Prediction models of erosion and nutrient transport from areas receiving manure should consider several factors, including manure type, manure loading rate, and time between application and rainfall. (Moore-IVI)

W84-04450

ESTIMATION OF NONPOINT SOURCE LOADINGS OF PHOSPHORUS FOR LAKES IN THE PUGET SOUND REGION, WASHINGTON

Geological Survey, Tacoma, WA, Water Resources Div., R. J. Gilliom.

For Sale by Distr. Br., USGS, 604 S. Pickett St., Alex., Va. 22304. USGS Water Supply Paper 2240. 1983. 24 p., 3 Fig., 7 Tab, 28 Ref.

Descriptors: Lakes, *Eutrophication, Phosphorus modeling, Phosphorus loading, *Mass-balance model, *Nutrients, Lake-water quality, Land-use/water-quality relationships, Nonpoint phosphorus loading, *Washington, Puget Sound region, Pacific Northwest.

Control of eutrophication of lakes in watersheds undergoing development is facilitated by estimates of the amounts of phosphorus (P) that reach the lakes from areas under various types of land use. Using a mass-balance model, P-loadings wer calculated from present-day P concentrations

measured in lake water and from other easily measured physical characteristics in a total of 28 lakes in drainage basins that contain only forest and residential land. The P-loadings from background sources to each of the lakes were estimated by methods developed in a previous study. Differences between estimated present day P-loadings and loadings from background sources were attributed to changes in land use. The mean increase in annual P yield resulting from conversion of forest to residential land use was 7 kilograms per square kilometer not including septic-tank system contributions. Calculated P-loadings from septic systems varied, and were found to correlate best with the number of lakeshore dwellings around each lake in 1940. The regression equation expressing this relationship explained 36 percent of the sample variance. For lakes in basins that contain agricultural land, the P-loading attributable to agriculture can be calculated as the difference between the estimated total loading and the sum of estimated loadings from all other (nonagricultural) sources. A comprehensive system for evaluating errors in all loading estimates is presented. The empirical relationships developed allow preliminary approximations of the cumulative impact that development has had on P-loading and the amounts of P-loading from generalized land-use categories for Puget Sound lowland lakes. All the estimates are most suitable for use in developing water-quality goals, setting priorities for lake studies, and designing studies of individual lakes. (USGS)
W85-00038

IDENTIFICATION OF FACTORS AFFECTING NITROGEN AND PHOSPHORUS LOADING TO LOUGH NEAGH

Department of Agriculture for Northern Ireland Antrim, Freshwater Biological Investigation Unit, R. H. Foy, R. V. Smith, R. J. Stevens, and D. A. Stewart.

Journal of Environmental Management, Vol. 15, No. 2, p. 109-129, September, 1982. 5 Fig., 10 Tab. 46 Ref.

Descriptors: *Nitrogen, *Phosphorus, *Pollution load, *Lough Neagh, *Water pollution sources, Multiple regression analysis, Cycling nutrients, Fertilization.

A stepwise multiple regression analysis was used to identify the factors affection nitrogen (N) and phosphorus (P) loss rates from six major rivers entering Lough Neagh over the period 1971-1979. Nitrate-N, Kjeldahl-N, soluble reactive P (SRP), soluble organic P (SOP) and particulate P (PP) were analyzed with independent catchment variables reflecting population, land use, industry and run-off rate. Urban population density was the dominant factor accounting for 44.0% of the variability of the SRP regression and the predicted per capita value (1.6 g P/person/day) agreed well with the observed value (1.8 g P/person/day). Milk processing plants contributed 4.6% of the variability and the predicted output was close to field measurements. The log of run-off was also an important determinant and contributed a further 20.8% of the variability, but all of the other variables failed to meet the criterion of significance. Intensity of dairy farming, shown to be highly correlated with N fertilizer usage, contributed 56.7% of the variability to the nitrate-N regression. Twelve % of the N fertilizer applied was lost in drainage water. The log of run-off contributed 21.4% of the variability and roughland was negatively correlated. All point source variables failed to meet the criterion of significance. Of the remaining chemical variables, only the PP regression produced a high R2 value, with the log of run-off being the dominant variable accounting for 43% of the variability. The regression equations were used to calculate total annual inputs to Lough Neagh of SRP and nitrate-N. A rise in the N/P ratio with time was observed. The SRP input could be reduced by 42%, if 90% P removal was practiced at the 18 largest sewage works. (Author's abstract)
W84-04816

IMPACT OF DETERGENT PHOSPHORUS BANS ON RECEIVING WATER QUALITY

Proctor and Gamble Co., Cincinnati, OH, Environmental Safety Dept., A. W. Maki, D. B. Porcella, and R. H. Wendt.

Water Research, Vol. 18, No. 7, p. 893-903, 1984. 3 Fig., 5 Tab, 52 Ref.

Descriptors: *Detergents, *Phosphorus, *Water quality, Indiana, New York, Michigan, Minnesota, Wisconsin, Sediments, Water pollution effects, Eutrophication.

Phosphorus (P) and its complexes are discharged as natural components of domestic wastewaters and include P from human waste and food waste as well as residual detergent P; significant amounts of P also reach surface waters from non-point sources such as agricultural and urban runoff. In a number of areas where legislation banned the sale of phosphorus detergents (Indiana, New York, Michigan, Minnesota, and Wisconsin), limnological investigations in natural lakes were carried out to assess the impact of the ban upon receiving water quality. The release of P from sediment, as well as the effect of thermocline migration, serves to increase productivity without affecting the external P budget. Detergent P bans represents a very small change in P loading, and no significant water-quality effects have been related to bans. Reductions of P in wastewaters, even up to 50%, may not substantially improve the trophic status of lakes. When P concentration is the primary factor causing eutrophication, water quality benefits can not be achieved by bans of detergent phosphorous. Such benefits required overall control of both point and non-point sources of phosphorus. (Collier-IVI)
W85-00558

IMPROVEMENTS IN QUANTIFYING THE PHOSPHORUS CONCENTRATIONS IN LAKE WATER

Alberta Univ., Edmonton, Dept. of Zoology, E. E. Prepas.
Canadian Journal of Fisheries and Aquatic Sciences, Vol. 39, No. 6, p. 822-829, June, 1982. 2 Fig., 4 Tab, 29 Ref.

Descriptors: *Particulate matter, *Phosphorus, *Sampling, Lakes, *Bob Lake, *Ontario, Oligotrophic lakes, Zooplankton, Variability, Water analysis, Pollutant identification, Stratification.

Phosphorus concentrations in oligotrophic Bob Lake, Ontario, were determined with smaller variance by dividing the total P pool into two fractions: dissolved and particulate matter smaller than 250 microns and particulate matter larger than 250 microns. Samples were collected at several stations and depths, the smaller fraction by water bottle, and the larger fraction by tow net. Digestion by potassium persulfate gave more repeatable results (average variance $<$ 0.05 mg P per cu m) than perchloric acid digestion at the low P concentration encountered, often less than 5 mg per cu m. During stratification a vertical P gradient in the smaller fraction was evident. P levels were lowest in the mixed large layer (4-6 mg per cu m), slightly less in the hypolimnion, with a maximum in the metalimnion (6-8 mg per cu m). There were small but significant differences in P levels of the smaller fraction at stations less than 1 km apart. Of the total P (smaller plus large fractions), 13-28% was contained in the larger fraction in the epilimnion. The percentage of total P decreased with depth, 4-12%in the metalimnion, $<$ 1-3% in the hypolimnion. Thus the larger particle fraction was concentrated in the epilimnion and the dissolved and smaller P-containing matter, in the metalimnion. Removing the larger fraction (containing a few zooplankton with highly variable amounts of P) reduced the average variance associated with the mean P from 1.0 to 0.024 mg per cu m. (Cassar-PRC)
W83-00208

INFLUENCE OF WITHIN-STREAM DISTURBANCE ON DISSOLVED NUTRIENT LEVELS DURING SPATES

Freshwater Biological Association, Wareham (England), River Lab, H. Casey and I. S. Farr.
Hydrobiologia, Vol. 92, p. 447-462, July, 1982. 8 Fig., 1 Tab, 31 Ref.
Department of the Environment, contract DGR 480/309.

Descriptors: *Dissolved nutrients, *Spates, *Freshets, *Nutrients, Streams, Organic carbon, Phosphates, Silicates, Nitrates, Potassium, Suspended solids, Bacteria, Organic matter.

In rivers, variations in concentrations of many dissolved nutrients occur during spates. Increases are usually attributed to concentrated point or non-point inputs, and decreases to dilution associated with rainfall. Increased discharge disturbs sediments and benthic communities, but the effects of such disturbance on nutrient levels are difficult to isolate. Measurements of nutrient levels over three artificial spates revealed that substantial variations in dissolved, organic carbon, dissolved phosphate, silicate, nitrate, and potassium levels could result from increased discharge in the absence of allochthonous inputs. Variations were closely related to peaks in suspended solids concentration or water height. Increases in biochemical oxygen demand and suspended bacteria also occurred. Variations in phosphate and silicate could be accounted for by a balance between release of "sediment interstitial water" and exchange processes involving suspended and freshly exposed sediment. An increase in nitrate, during one spate, was due to a reduction in the effect of benthic denitrification. Small peaks in dissolved organic matter concentration were detected over each spate. We propose that within-stream disturbance is a factor which may contribute to variations in dissolved nutrient concentration during the rising hydrograph in natural spates. (Author's abstract)
W85-02089

LAK-WIDE SEASONAL CHANGES IN LIMNOLOGICAL CONDITIONS IN LAKE MICHIGAN IN 1976

Manhattan Coll., Bronx, NY, C. R. Bartone, and C. L. Schelske.
Journal of Great Lakes Research, Vol. 8, No. 3, p. 413-427, 1982. 10 Fig., 3 Tab, 33 Ref.

Descriptors: *Lakes, *Limnology, *Lake Michigan, Great Lakes, Algae, Phosphorus, Nutrients, Eutrophication, Chlorophyll, Light intensity, Light penetration.

A synthesis is presented of some of the results obtained from a lake-wide sampling that was conducted as part of a research program on eutrophication processes in Lake Michigan. The average water temperature was cooler and average water transparency was greater in the northern lake than in the southern, but with the exception of total phosphorus, average nutrient concentrations did not differ between the northern and southern parts. It was found that physical-chemical characteristics of nearshore and Straits of Mackinac stations differed significantly from open lake stations. Seasonal phytoplankton dynamics in the open lake were related to seasonal and vertical changes in silica and nitrate nitrogen. The spring phytoplankton bloom occurred before the lake was strongly stratified thermally. After thermal stratification was well developed, epilimnetic concentrations of chlorophyll-a decreased, probably due to some combination of nutrient limitation and zooplankton grazing, and maximum chlorophyll-a concentrations were found below the thermocline. Epilimnetic silica concentrations decreased after thermal stratification, and diatoms were replaced in the phytoplankton assemblage by green and blue-green algae in late summer. Total phosphorus averaged only 8 micrograms/liter on a lake-wide basis, and only small but significant reductions in absolute concentration can be expected from phosphorus control programs. Over a period of years, however, these small reductions may be difficult to verify from total phosphorus measurements, which have relatively large sampling errors and variances. (Baker-FRC)
W83-03079

LOADING FUNCTIONS FOR PREDICTING NUTRIENT LOSSES FROM COMPLEX WATERSHEDS

Clemson Univ., SC. Dept. of Agricultural Economics and Rural Sociology, L. L. D. Delwiche, and D. A. Haith.
Water Resources Bulletin, Vol. 19, No. 6, p. 951-959, December, 1983. 1 Fig., 8 Tab, 27 Ref.

Descriptors: *Water pollution sources, *Nonpoint pollution sources, *Nutrients, *Watersheds, Mathematical models, Load function, Croplands, Forests, Urban areas, Animal wastes, Effluents, Groundwater discharge, West Branch Delaware River, New York.

A loading function methodology is presented for predicting runoff, sediment and nutrient losses from complex watersheds. Separate models are defined for cropland, forest, urban and barnyard sources, and procedures for estimating baseflow nutrients are provided. The loading functions are designed for use as a preliminary screening tool to isolate the major contributors in a watershed. Input data sources are readily available and the functions do not require costly calibrations. Data requirements include watershed land use and soil information, daily precipitation and temperature records and rainfall erosivities. Comparison of predicted and measured water, sediment, and nutrient runoff fluxes for the West Branch Delaware River in New York, indicated that runoff was underpredicted by about 14% while dissolved nutrients were within 30% of observed values. Sediment and solid-phase nutrients were overpredicted by about 50%. An annual nutrient budget for the West Branch Delaware River showed that cornland was the major source of sediment, solid-phase nutrients, and total phosphorus. Waste water treatment plants and ground water discharge contributed the most dissolved phosphorus and dissolved nitrogen, respectively. (Author's abstract).
W84-03400

MAJOR PROCEDURAL DISCREPANCIES IN SOIL EXTRACTED NITRATE LEVELS AND NITROGEN ISOTOPIC VALUES

Nebraska Univ.-Lincoln, NE, Inst. of Agricultural and Natural Resources. C. W. Lindau and R. F. Spalding.
Ground Water, Vol. 22 No. 3, May-June, 1984. 4 Fig., 1 Tab, 23 Ref.

Descriptors: *Groundwater pollution, *Nitrates, *Vadose water, *Nebraska, Nitrogen, Path of pollutants, Nitrogen radioisotopes, Leaching.

Samples were collected from an area encompassing 144 sq miles of Gage, Saline, and Jefferson counties in southeastern Nebraska. Most of the study area received about 28 inches of precipitation and is composed of flat-lying plains dissected by river and creek valleys. The preliminary data from the five cores indicated that the concentrations of extractable NO3-N and delta-N-15 values are influenced by the volume of extractant (2N KC1). Use of the 1:1 ratio results in underestimating the available N03-N for leaching through the vadose zone and a probable misinterpretation of the sources of nitrate contamination. More study is needed to determine whether extractable nitrate concentrations and nitrogen isotopic values are influenced by changes in soil properties and by the type of extractant used. It appears logical that samples very high in nitrate necessitate soil-to-extractant (2N CK1) ratios equal to or greater than 1:10, while ratios of 1:5 may be sufficient for samples low in nitrate. (Baker-IVI)
W84-05102

MASS BALANCE MODEL ESTIMATION OF PHOSPHORUS CONCENTRATIONS IN RESERVOIRS

Bureau of Reclamation, Denver, CO, Engineering Research Center, D. K. Mueller.
Water Resources Bulletin, Vol. 18, No. 3, p. 377-382, June, 1982, 6 Fig., 7 Tab, 15 Ref.

Descriptors: *Water quality control, *Phosphorus, *Eutrophication, *Model studies, *Reservoirs, Mathematical models, Lakes, Water Quality management, Artificial lakes, Nutrients, Mathematical studies.

Mass balance models are useful tools in the control of phosphorus induced eutrophication of lakes, but their applicability to reservoirs, especially those of the Western United States, has not yet been verified. Using data from the United States Environmental Protection Agency National Eutrophication Survey, such a verification was attempted for 68 reservoirs from 11 Western states. Several models commonly used in lake quality assessments were compared for accuracy in application to the reservoir data by model standard error and correlation between estimated and observed reservoir phosphorus concentrations. The model of Dillion and Rigler, which uses phosphorus retention calculated from observed data, proved the most accurate with a correlation coefficient of 0.86 and a standard error of 0.2, based on logarithmic transformed values. Other models considered included the Vollenweider-1975 model which assumes a constant settling velocity, the Jones-Bachmann model which assumes a constant sedimentation coefficient, the Dillion-Kirchner model which estimates phosphorus retention as a function of hydraulic load, and the Vollenweider-1976 model which estimates phosphorus flushing from the inverse of hydraulic detention. These models displayed deficiencies in model formulation and in coefficient adaptation to lake data. (Geiger-FRC)
W83-00009

MUNICIPAL POINT SOURCE AND AGRICULTURAL NONPOINT SOURCE CONTRIBUTION TO COASTAL EUTROPHICATION

Tennessee Valley Authority, Knoxville, TN, A. M. Duda.
Water Resources Bulletin, Vol. 18, No. 3, p. 397-407, June, 1982. 6 Fig., 2 Tab, 42 Ref.

Descriptors: *Coastal pollution, *Water pollution effects, *Eutrophication, *Farm wastes, *Estuaries, *Water pollution sources, Nutrients, Animal wastes, Fishkill, Tidal rivers, Tidal effects, Nuisance algae, Municipal wastes, Coastal waters, Nitrogen, Phosphorus, Nitrates, *North Carolina, Chowan River.

Some tidal coastal rivers of eastern North Carolina are suffering from serious water quality deterioration in the form of massive algal blooms, fish kills, red sore disease among fish, fresh water intrusion into estuaries and decline of commercial and sport fishing. A study of point and nonpoint sources of nutrient inputs was carried out on the eutrophic Chowan River. Nonpoint source loading was the major cause of nutrient flux from the river basin, accounting for 97% of the nitrogen and 94% of the phosphorus load entering the Chowan River watershed. Levels of nitrate nitrogen and total phosphorus were from 5 to 40 times grater in agricultural watershed than in forested watersheds of the river basin. The timing of the spring input of nutrients from nonpoint sources and the high levels of nutrients recorded in agricultural watersheds implicate agricultural sources as an important factor in determining whether massive blooms of blue-green algae occur during a given year in the Chowan River. In years with high spring precipitation, massive surface blooms of algae have occurred. In years with low spring flows, the noxious blooms do not occur despite continued input of municipal and industrial point source discharges. The present data suggests that the coastal eutrophication in question is arising mainly from farming and animal operations along the Chowan River basin. Agricultural drainage improvement such as tile drains, intensive ditch systems, and channelization projects through wetlands may ease the situation. (Geiger-FRC)
W83-0001

NATURE OF PHOSPHORUS FRACTIONS IN LAND RUNOFF AND THEIR AVAILABILITY TO ALGAE

Cornell Univ., Ithaca, NY, J. P. Barlow, D. R. Bouldin, R. T. Oglesby, W. R. Schaffner, and M. S. Glase.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111830, Price codes: A04 in paper copy, A01 in microfiche. Center for Environmental Research Completion Report, (1983). 63 p., 15 Fig., 11 Tab, 15 Ref. OWRT B-098-NY(1), 14-34-0001-1251.

Descriptors: *Phosphorus, *Biological availability, *Algal assay, Reactive phosphorus, Organic phosphorus, Sorption, Particulate phosphorus, Soil nutrient losses, *Agricultural runoff, New York.

Phosphorus in agricultural discharge and streams was examined for biological availability of soluble fractions and for the quantity of these in discharge. In streams, very little soluble P was detected, even during heavy flow. Although there was considerable variability in the concentration of P discharged from fields, the total amount lost was closely related to the amount of water discharged. Soluble P, both molybdate reactive and unreactive was largely biologically available as determined by algal bioassays and bioassays using natural pond microfloral assemblages. Soluble P which was less available after herbicide treatment or frosts many have resulted from breakdown of plant material. Sorption reactions during mixing of field discharge with stream water were estimated by adding increasing amounts of low P water to discharge water. Generally, soluble molybdate reactive P was absorbed and decreased in concentration while soluble unreactive P was desorbed and increased in concentration. Sorption was related to the quantity of suspended particulates.
W84-00043

NITRATE LOSS FROM AGRICULTURAL DRAINAGE WATERS: IMPLICATIONS FOR NON-POINT SOURCE CONTROL

North Carolina State Univ. at Raleigh, NC, Dept. of Soil Sciences, T. C. Jacobs and J. W. Gilliam.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-140581, Price codes: All in paper copy, A01 in microfiche. North Carolina Water Resources Research Institute Completion Report No. 209, September 1983. 222 p., 50 Fig., 27 Tab, 34 Ref. 12 Append. OWRT B-129-NC(1), 14-34-0001-0238.

Descriptors: *Denitrification, *Drainage effects, *Buffers, *Agricultural watersheds, *Nitrogen losses, *Nitrogen movement, Nitrates, Soil water movement, Riparian vegetation, Water pollution sources, Fertilizers, Drainage water, Subsurface drainage, Surface runoff, *North Carolina, Coastal plain.

The amount and fate of nitrogen moving from agricultural fields in two watersheds of the North Carolina Coastal Plain were examined. The possible sinks for this nitrogen and their effects on stream concentration were determined. At the Beaverdam Creek watershed where well- and moderately well-drained soils dominate the agricultural fields, nitrogen readily moved from the fields. However, between most fields and the natural streams, there were buffer strips with heavy riparian vegetation. These buffer areas with poorly drained soils resulted in significant losses of nitrate before the water reached the stream. Very narrow buffer strips were effective for this removal and these strips normally line streams on the Middle Coastal Plain. In soils with subsurface drainage entering ditches via tile lines or subsurface flow, the losses of nitrogen of surface waters were much greater. In watersheds of the Upper and Middle Coastal Plain in-stream losses of nitrogen are not sufficient to reduce heavy loading by nonpoint sources. The floodplains, which have a high capacity to reduce nitrate, usually flood in the winter when temperatures are too low for extensive losses. At the Creeping Swamp watershed in the Lower Coastal Plain, a dense clay layer below the surface horizons reduces subsurface drainage losses of water and nitrogen to very low levels.
W84-00965

NITROGEN AND PHOSPHORUS DEPENDENCE OF ALGAL BIOMASS IN LAKES: AN EMPIRICAL AND THEORETICAL ANALYSIS

Minnesota Univ., Minneapolis, MN, Limnological Research Center, V. H. Smith
Limnoiogy and Oceanography, Vol. 27, No. 6, p. 1011-1112, November, 1982. 6 Fig., 5 Tab, 58 Ref. NSF grant DEB77-15069.

Descriptors: *Lakes, *Nitrogen, *Phosphorus, *Biomass, *Algae, Eutrophication, Algal growth, Chlorophyll, Prediction, Phytoplankton.

An analysis of mean growing season concentrations of chlorophyll, total phosphorus and total nitrogen in 228 north latitude lakes confirms previous observation that chlorophyll yield is dependent both on the phosphorus concentration and on the total nitrogen-total phosphorus ratio. Of two modified chlorophyll models which depend explicitly on both N and P developed and tested, one, a multiple regression model, appears to greatly reduce the error of chlorophyll prediction in lakes. A theoretical framework is presented which provides an explanation for the observed effects of N:P ratios. The effects of N:P ratios on algal biomass appear to be the results of differences in the nutrient physiology of different algal species. Data have confirmed that the amount of chlorophyll produced by a given concentration of total P is sensitive to variations in the N:P ratio. Further data suggest that a similar effect-will be found for total cell volume. Thus, variations in the TN:TP ratio seem to be responsible for a substantial portion of the scatter observed in previous phosphorus chlorophyll regressions and probably also in phosphorus-cell volume regressions. The effects of the TN:TP ratio on algal biomass appear to be driven by species shifts in the phytoplankton. (Baker-IV)
W85-01603

NITROGEN AND PHOSPHORUS IN THE NGONGOTAHA STREAM

Ministry of Works and Development, Hamilton (New Zealand), Water and Soil Science Centre, R. A. Hoare.
New Zealand Journal of Marine and Freshwater Research, Vol. 16, No. 3/4, p. 339-349, 1982. 8 Fig., 4 Tab, 13 Ref.

Descriptors: *Ngongotaha Stream, *New Zealand, *Rotorua, *Nitrogen, *Phosphorus, Base flow, Flood flow, Nitrates, Ammonia, Kjeldahl procedure, Nutrients.

The nitrogen and phosphorus loads of the Ngongotaha Stream, near Rotorua, New Zealand were determined for 1976 and 1977 and a novel way to define a flow-concentration curve was developed. There was a clear distinction between total P concentrations in base flow and in flood flow of the stream. In base flow, the concentrations were independent of flow rate, as well as being low, while in floods the concentrations became very strongly dependent on flow rate. Nitrate, ammonia, dissolved reactive phosphorus (DRP), total phosphorus (TP), and total Kjeldahl nitrogen (TKN) concentrations were measured, mean concentrations in 1976 base flow were found to be 527, 25, 32, 48, and 162 mg/cu m respectively. Nitrate concentrations showed seasonal variations, and although changes occurred during floods, they were not correlated with flow rate. DRP concentrations showed little variation, except that they dropped at the peak of the largest floods. TP was strongly correlated with flow rate during floods, and TP loads could best be calculated by allowing for a curvilinear relationship between concentration and flow rate. The logarithms of the TP load carried by a flood and the peak flow rate of the flood were highly correlated (R = 0.984). The loads of nitrate-N, ammonia-N, DRP, TP, and TKN in 1976 were estimated to be 34, 1.3, 6.0, and 26 tons. (Collier-IVI)
W85-01635

NITROGEN LOSS FROM A HIGH-FERTILITY, ROTATIONAL PASTURE PROGRAM

Science and Education Administration, Coshocton, OH, L. B. Owens, R. W. Van Keuren, and W. M. Edwards.
Journal of Environmental Quality, Vol. 12, No. 3, p. 346-350, July-September, 1983. 3 Fig., 5 Tab, 17 Ref.

Descriptors: *Grazing, *Pasture management, *Water pollution sources, *Cattle, Agricultural runoff, Agricultural watersheds, Nonpoint pollution sources, Storm seepage, Nitrogen, Fertilizers, Nitrates, Ohio.

A beef cattle-pasturing system involving four rotationally grazed summer pastures (SG) and four pastures used rotationally for winter grazing/feeding (WGF) was studied on sloping upland watersheds in Ohio to determine effects of livestock management on N levels in water. Both summer and winter areas annually received 224 kg N/ha as NH4N03 fertilizer. Surface runoff was collected automatically during runoff events, and subsurface flow was sampled from spring development on a weekly basis. Although seasonal N concentration and transport in surface runoff. tended to be greater in the area occupied by the cattle, N concentration and transport in runoff from the two areas were quite similar and did not significantly impair water quality, based on U. S. Public Health Standards. The N03-N concentration in the subsurface flow from the WGF area was higher than in the subsurface flow from the SQ area. The N03-N concentration in the subsurface flow from both areas increased progressively throughout the study period, and reached levels as high as 18 mg/L. The subsurface flow provided the main pathway for N transport, with the surface transport being approximately 20 and 14% of the total N transport from the SG and WGF areas, respectively. The amount of sediment-N transported was very small because of low soil loss. (Author's abstract)
W84-01808

NONPOINT WATER QUALITY CONDITIONS FROM LAND USE

Arizona Univ., Tucson, AZ, School of Renewable Natural Resources, C. Wilkin and R. W. Jackson.

Journal of Environmental Systems, Vol. 13, No. 2, p. 127-136, 1983-84. 1 Fig, 2 Tab, 8 Ref.

Descriptors: *Nonpoint pollution sources, *Land use, *Water pollution sources, Phosphorus, Nitrates, Water quality, Sediment barriers, Floodplains, Watershed management, Trap efficiency, Reservoirs.

Stream loads of total phosphorus and nitrate-nitrogen were studied as a function of land use in a midwestern watershed of 5,853 sq km by means of ordinary least squares (OLS) regression analysis. The purpose was to test the general hypothesis that the variance in chemical water quality from undefined sources is a function of land use within the watershed, and to begin to study the hypothesis than land use near the stream is more important that land use far from the stream in affecting water quality from nonpoint sources. Results support both hypotheses. Further, these results suggest the importance of considering the means by which chemicals are delivered to the stream. Nitrate-nitrogen and phosphorus can apparently both be purposely intercepted, but by different means because of their different delivery systems. Nitrate-nitrogen can be intercepted by removal of fastgrowing floodplain crops, and phosphorus by sediment barriers outside the floodplain. Evidence also suggests trap efficiency in reservoirs is important in improving downstream water quality. (Author's abstract)
W84-02683

NUTRIENT CYCLING IN AN AGRICULTURAL WATERSHED: II STREAMFLOW AND ARTIFICIAL DRAINAGE

Agricultural Research Service, Tifton, GA, Southeast Watershed Research Center, R. R. Lowrance, R. L. Todd, and L. E. Asmussen.
Journal of Environmental quality, Vol. 13, No. 1, p. 27-32, January-March, 1984. 4 Fig., 2 Tab, 23 Ref. NSF grants DEB 78-10841 and DEB 82-07210.

Descriptors: *Agricultural watershed, *Streamflow, *Drainage water, *Nutrient cycling, Water pollution sources, Nitrogen, Phosphorus, Calcium, Potassium, Chloride, Sulfates, Seasonal variation, Sediment load.

Streamflow is an important means of nutrient export off most watersheds. In agricultural areas, effluent from artificial drainage can be an important contribution to streamflow nutrient loads. The objective of this study was to examine seasonal variations of nutrients in streamflow and to quantify the effects of artificial drainage effluent on streamflow nutrients on an agricultural watershed. Concentrations and loads of N03-N, NH4-N, organic N, dissolved molybdate-reactive P, total P, Ca, Mg, K, Cl, and S04-S were measured in streamflow and artificial drainflow on a 1568-ha agricultural watershed near Tifton, GA. All 10 streamflow sampling sites had maximum N03-N and S04-S concentrations in winter and most reached minima during summer. Concentrations of N03-N, Ca, Mg, Km and Cl were generally much higher in drainage water than streamflow. Load of N03-N from drained row-crop fields was about 40.4 kg/ha/y, 60 times the per-hectare N03-N load from the mixed cover watershed. Loads of organic N, Ca, Mg, K, S04-S, and Cl from the mixed cover watershed were 2.8, 9.3, 4.5, 6.5, 17.0, and 30.0 kg/ha/y, respectively. Loads (per hectare) of organic N were lower from the drained fields, but loads of Ca, Mg, K. S04-S, and Cl were from the mixed cover watershed. In-stream and riparian zone processes apparently converted inorganic N to organic forms and removed N through denitrification. Annual streamflow N load was about 29% of the precipitation input of 12.2 kg/ha/y. Sediment-associated N and p loads in streamflow were 0.35 and 0.09 kg/ha/y, respectively, accounting for 9.0 and 8.5% of total N and P, respectively. The two highest flow events for the year carried 19% of the total annual flow and 19% of the annual sediment load, but had 30 and 27% of the total annual sediment N and P loads, respectively. This enrichment of sediment-associated N and P indicated that part of this sediment load moved directly from upland areas. (Author's abstract)
W84-04602

NUTRIENT LOADING ESTIMATES FOR LAKES

Geological Survey, Sacramento, CA, W. Rast and G. F. Lee.
Journal of Environmental Engineering, Vol. 109, No. 2, p. 502-517, April, 1983. 3 Fig., 2 Tab, 40 Ref.

Descriptors: *Nutrients, *Nitrogen, *Phosphorus, *Lakes, *Pollution load, Land use, Watersheds, mathematical models, Nutrient load.

The nitrogen and phosphorus loads to a waterbody may be reliably estimated on the basis of the waterbody's watershed land use pattern and the nitrogen and phosphorus export coefficients for each dominant type of land use. Good agreement was found in a comparison between the nitrogen and phosphorus export coefficients developed in this study and the measured amounts of nitrogen and phosphorus transported to 38 U. S. waterbodies. Good agreement was also found between the load estimated by the Vollenweider model relating the mean annual in-lake and in-flow phosphorus concentrations of a waterbody, and the measured amounts of phosphorus that actually entered the 38 waterbodies. (Author's abstract)
W84-01111

NUTRIENT LOSSES IN RUNOFF FROM CONVENTIONAL AND NO-TILL CORN WATERSHEDS

Maryland Univ., College Park, MD, Dept. of Agronomy, J. S. Angle, G. McClung, M. S. McIntosh, P. M. Thomas, and D. C. Wolf.
Journal of Environmental Quality, Vol. 13, No. 3, p. 431-435, July-September, 1984. 3 Tab, 24 Ref.

Descriptors: *Nutrient removal, *Runoff, *Tillage, *Corn, Agricultural watersheds, Nonpoint source pollution, Nitrogen, Phosphorus, Sediment transport, Sediment erosion.

Possible differences were investigated between the quantity and quality of runoff from conventional and reduced tillage corn. Over nine times more runoff originated from the conventional-till watershed when compared with the no-till watershed in 1982. A large difference between the two watersheds in suspended sediment content was also noted. Yearly sediment losses of 370 and 9 kg/ha from the conventional and no-till watersheds, respectively, were found for 1982. There was also a significant difference in the loss of soluble solids between the two watersheds. For 1982, there was over a 29-fold greater loss of soluble solids from the conventional-till watershed than from the no-till watershed. Losses of ammonia-nitrogen, nitrate-nitrogen, and total nitrogen from each watershed were very low. Large differences were noted between the two watersheds. The loss of all forms of P from each watershed was also very small. During 1982 161 g/ha of total P were lost from the conventional till watershed while only 8 g/ha were lost from the no-till watershed. The loss of orthophosphate and total soluble P was not significantly different between the two tillage treatments. Differences in both the volume of runoff and the quality of the runoff between the two tillage systems occurred most often after the spring cultivation and before the crop canopy fully covered the soil surface. Total runoff from both watersheds was much lower than previously reported data and resulted in a correspondingly low loss of nutrients. (Baker-IVI)
W85-01290

PARTITIONING OF PHOSPHORUS BETWEEN PARTICLES AND WATER IN A RIVER OUTFLOW

New York State Coll. of Agricultural and Life Sciences, Ithaca, NY, Ecology and Systematics Section, J. P. Barlow and M. S. Glase.
Hydrobiologia, Vol. 91, p. 253-260, July, 1982. 7 Fig., 1 Tab, 14 Ref.

Descriptors: *Cayuga lake, *New York, *Salmon Creek, *Phosphorus, *Particulate matter, Mixing zone, Adsorption, Chemical precipitation, Sedimentation, Nutrients.

The mixing zone between Cayuga Lake, N.Y. and one of its tributaries, Salmon Creek, was studied to determine effects of physical processes such as adsorption, precipitation or sedimentation on phosphorus discharge by the Creek. A high sodium concentration in the lake served as a natural tracer, by which proportions of Creek and Lake water were determined at any point in the mixing zone. Proportions of Creek and Lake water were used to predict amounts of P that would be expected on the basis of mixing alone. Differences between predicted and observed concentrations were attributed to local physical processes. In several of the six plumes surveyed, there was substantial loss of P due to sedimentation. The P-distribution in all plumes showed evidence of exchanges between particles and the medium, as a result of which soluble reactive-P usually decreased and soluble unreactive-P usually increased. The nature and magnitude of these local processes were such that they could have significant effects on the fate of stream-P discharged into the lake) (Author's abstract)
W85-02075

PEAK NITRATE-NITROGEN VALUES IN SURFACE RUNOFF FROM FERTILIZED PASTURES

Agricultural Research Service, Coshocton, OH, North Appalachian Experimental Watershed, L. B. Owens, W. M. Edwards, and R. W. VanKeuren.
Journal of Environmental Quality, Vol. 13, No. 2, p. 310-312, April-June, 1984. 1 Fig., 3 Tab, 13 Ref. EPA grant R-804631.

Descriptors: *Pastures, *Nitrates, *Fertilizers, *Water pollution sources, *Ohio, Grazing, Animal wastes, Agricultural runoff, Surface runoff.

Pastured watershed on hill slopes in eastern Ohio were fertilized with ammonium nitrate (NH4N03) at two different levels for 5 years. The pastures were rotationally grazed during either the growing season (May-October) or the dormant season (November-April). Nitrate-N concentrations were measured in surface runoff events $>$ 0.1 mm from nine watersheds. During the 5-year period, there were 890 runoff events. Sixty-four of these events (7%) had N03-N concentrations $>$ 10 mg/L, and 48 of the 64 events occurred within a 30-day period following fertilizer application. Ten events, $<$ 2/of all of the runoff events, exceeded 30 mg/L N03-N, and all of these were within 17 days of fertilization. Although all surface runoff events which closely followed fertilizer applications did not have high N03-N concentrations, all surface runoff with high N03-N was shortly preceded with a fertilizer application. The closeness of the high N03-N concentration and fertilizations suggested that fertilizer was the major contributor to high N03-N in runoff as opposed to animal waste. (Author's abstract)
W84-05123

PHOSPHORUS FLUX RATES IN LAKE SEDIMENTS

Washington State Water Research Center, Pullman, WA, S. J. Mawson, H. L. Gibbons, Jr., W. H. Funk, and K. E. Hartz.
Journal of the Water Pollution Control Federation, Vol. 55, No. 8, p. 1105-1110, August, 1983, 3 Fig, 3 Tab, 23 Ref. EPA contract R805604-01.

Descriptors: *Phosphorus, *Lake sediments, Liberty Lake, Washington, Sediments, Dissolved oxygen, Sediment-water interfaces, Interfaces, Mud-water interfaces.

The release of phosphorus from Liberty Lake sediments was quantified as a function of dissolved oxygen concentrations at the sediment water interface. Liberty Lake sediments range from sand overlying clay at the northwest end to consolidated fibrous plant detrital materials at the south end. A significant release of phosphorus was noted, ranging from a maximum for total phosphorus in the refractory organic silt (ROS) sediments of 127 micrograms/sq m/hr under

anaerobic conditions to a minimum of .000979 micrograms/sq m/hr for soluble reactive phosphate (SRP) under aerobic conditions. Maximum release rate observed for heavy organic muck (HOM) sediments was 54.2 micrograms/sq m/hr for total phosphorus under anaerobic conditions. The impact of the release on the phosphorus loading of the lake is a function of the dissolved oxygen concentration at the sediment water interface. The release of soluble reactive phosphate (SRP) is greatest from the HOM sediment, probably due to the greater interstitial phosphate concentrations present in these sediments. (Baker-IVI)
W84-02578

PHYTOPLANKTON UPTAKE AND SEDIMENT RELEASE OF NITROGEN AND PHOSPHORUS IN THE CHOWAN RIVER, NORTH CAROLINA

North Carolina Univ. at Chapel Hill, NC, Dept. of Environment Sciences and Engineering, E. J. Kuenzler, K. L. Stone, and D. B. Albert.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-105444, Price codes: A10 in paper copy, A01 in microfiche. Water Resources Research Institute Report No. 186, North Carolina State Univ., Raleigh, September 1982. 159 p., 40 Fig., 18 Tab, 145 Ref, 1 Append. OWRT B-127-NC(12), 14-34-0001-0274.

Descriptors: *Eutrophication, *Nutrients, *Limiting nutrients, *Phytoplankton, Algae, Cyanophyta, Seston, Nitrogen, Nitrate, Ammonium, Phosphorus, Phosphate, Sediments, Radioactive tracers, *North Carolina, Chowan River, Algal blooms.

The lower part of the Chowan River has suffered from blue-green algal blooms in recent years as a result of increased loading of nutrients. These nutrients (nitrate, ammonium, and phosphate) were reduced to lower concentrations during the warm seasons when algal growth was rapid and were more concentrated in winter and early spring when ammonium and phosphate were introduced by pulp-mill effluent. Uptake of ammonium by seston varied greatly; it was fastest during the blue-green bloom. Nitrate uptake averaged only a third as fast as the annual ammonium uptake rate. Phosphate uptake was predominantly biotic; the rates varied, with highest rates occurring at downstream stations in warm weather when algae were abundant. Fluxes of ammonium and phosphate from the sediments to the water were highly variable. Although nitrogen and phosphorus are abundant in the sediment, the rate of exchange to the overlying water is not the basic cause of the eutrophic condition of the water column. Analysis suggests that nitrogen or phosphorus may limit algal growth at different times and places in the river. However, indications are that phosphorus is the more important limiting nutrient. Elimination of the algal bloom problem in the Chowan River will be accomplished only by reducing nutrient loading from the watershed, especially phosphorus loading.
W83-04146

POTENTIAL MOBILITY OF PHOSPHORUS IN DIFFERENT TYPES OF LAKE SEDIMENT

Uppsala Univ. (Sweden). Limnologiska Institutionen, B. Bostrom.
Internationale Revue der Gesamten Hydrobiologie, Vol. 69, No. 4, p. 457-474, 1984.

Descriptors: *Phosphorus, *Sweden, *Lakes, *Lake sediment, Physicochemical analysis, Chemical analysis, Hydrogen ion concentration, Trophic level, Aluminum, Iron, Nutrients.

Internal loading of phosphorus from sediments often leads to maintenance of high trophic levels in lakes after drastic reductions of nutrient inputs. An approach for determining the prerequisites for internal phosphorus loading from different sediments is to analyze the fractional distribution of the sedimentary phosphorus and to then determine the proportion that is potentially mobile within the naturally occurring range of variation for the most important environmental factors. The fractional composition and potential mobility of sediment phosphorus was investigated in nine Swedish lakes with different characteristics. Differences between sediments regarding P release patterns in laboratory experiments with varying pH and redox conditions could largely be explained by differences in the fractional composition of the sedimentary P. Sediments from sewage-loaded lakes contained considerably more loosely adsorbed P than unpolluted lakes. P release was redox-sensitive and strongly favored by high pH values in sediments with a high content of aluminum and iron-bound P. Other sediments released primarily organic and loosely adsorbed P, and in such cases less P was released and redox and pH conditions had less effect. For most sediments, the release rates measured in the laboratory were similar to those determined from mass balance calculations for the lakes. (Collier-IVI)
W85-02567

PREDICTION OF PHOSPHORUS LOSSES IN RUNOFF FROM SOUTHERN PLAINS WATERSHEDS

Oklahoma State Univ., Stillwater, OK, Dept. of Agronomy. A. N. Sharpley, S. J. Smith, and R. G. Menzel.
Journal of Environmental Quality, Vol. 11, No. 2, p. 247-251, April-June, 1982. 2 Fig., 5 Tab, 23 Ref.

Descriptors: *Phosphorus, *Rainfall-runoff relationships, Runoff, *Prediction, Mathematical models, Soil erosion, Watersheds, Grasslands, Cropland, Sediment discharge, Performance evaluation, *Simulation analysis, *Southern Plains, Model studies, *CREAMS model, *Path of pollutants.

Relationships developed from simulated rainfall-runoff experiments on soils collected from several cropland and grassland watersheds in the Southern Plains and used to predict the losses of soluble and particulate phosphorus in runoff from these watersheds were evaluated. Soluble

phosphorus was predicted from the water-extractable phosphorus content of surface soil (to a depth of 1 centimeter) collected in March of each year, using a general phosphorus-extraction coefficient covering all of the soils found in the subject watersheds. For individual soils, the phosphorus-extraction coefficient was related to the depth of interaction between surface soil and runoff. The level of phosphorus attached to eroded soil transported in runoff was predicted from the total phosphorus content of surface soil collected in March of each year using phosphorus-enrichment ratios calculated from sediment discharge. The predictions of mean annual soluble and particulate phosphorus concentrations with different fertilizer and watershed management practices, soil types, and vegetative covers. The results indicate that the relationships used in the CREAMS (Chemicals, Runoff, and Erosion from Agricultural Management Systems) model can provide accurate predictions of mean annual soluble and total phosphorus concentrations in runoff. (Carroll-FRC)
W83-01979

PRELIMINARY ESTIMATE OF NUTRIENT RUN-OFF INTO TWO LAKES IN THE LECZYNSKO-WLODAWSKIE LAKE DISTRICT THROUGHOUT A YEAR

Akademia Rolnicza, Lublin (Poland). Inst. of Soil Science and Agricultural Chemistry, H. Smal and M. Misztal.
Act Hydrobiologica, Vol. 24, No. 3, p. 187-196, 1982. 1 Fig., 4 Tab, 8 Ref.

Descriptors: *Runoff, *Nitrates, *Water pollution sources, *Poland, *Lakes, *Leczynsko-Wlodawskie Lake, Agricultural chemicals, Nutrients.

The investigation of nutrient run-off to water bodies is of great interest in view of the progressive deterioration of water quality due to pollution, poisoning, and eutrophication. Such an investigation was started in the Leczynsko-Wlodawskie Lake District where agriculture in the region has been intensified and a rapid development has been noted in tourism. During the year of study the concentration of elements and their forms in water greatly varied in the different sectors of the Lake Piaseczno catchment. In the catchment of Lake Bialka greater differences appeared in the case of sodium and magnesium ions. The highest concentration of nitrates was found in the ground waters of the agricultural sector of Lake Piaseczno catchment. (Baker-IVI)
W85-02508

RELATIONSHIPS BETWEEN WATER QUALITY AND PHOSPHORUS CONCENTRATIONS FOR PUGET SOUND REGION LAKES

Geological Survey, Reston, Va., R. J. Gilliom.
Water Resources Bulletin, Vol. 20, No. 3, p. 435-442, June, 1984. 3 Fig., 1 Tab, 34 Ref.

Descriptors: *Phosphorus, *Water quality, *Eutrophication, *Lakes, Limiting nutrients, Chlorophyll, Transparency, Prediction, Water quality control.

Many of the lakes in the Puget Sound region are threatened by eutrophication related water quality problems associated with increased nutrient loading from urban and agricultural land uses in their watersheds. The most cost effective approach to managing eutrophication is usually to control the supply of nutrients to a lake. Regression relationships were developed between summer mean total phosphors (P) concentrations in near-surface water and both chlorophyll a concentrations and Secchi disc transparency for use in the management of Puget Sound region lakes. Total P concentrations in the lakes studied ranged from 7 to 66 micro g/L. The relationship between total P and chlorophyll a. based on data from 69 lakes, explained 57% of the variance in chlorophyll a. Predicted chlorophyll a concentrations and 95% confidence intervals ranged from 1 (+ 3, 05) micro g/L for 7 micro g/L P to about 16 (+ 35, −10) micro g/L for 66 micro g/L P. The relationship between total P and Secchi disc, based on data from 71 lakes, explained 53% of the variance in Secchi disc. Predicted Secchi disc transparencies and 95% confidence intervals ranged from 5.5 (+ 5.5, −3.0 m) for 7 micro g/L P to 1.4 (+ 1.5, −0.7 m) for 66 micro g/L P. Often the greatest uncertainty in predicting the response of a lake to management actions for reducing P levels or to development actions which increase P levels is in what the resultant P level will be. The most appropriate approach to expressing this uncertainty may be to make best and worst case estimates of P levels in addition to the most likely outcome and to use this range of estimates to evaluate potential changes in chlorophyll concentrations and transparency. (Moore-IVI)
W85-01379

SOLUBLE REACTIVE PHOSPHORUS MEASUREMENTS IN LAKE MICHIGAN: CAUSES OF METHOD-SPECIFIC DIFFERENCES

National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab, S. J. Tarapchak, R. L. Chambers, and S. M. Bigelow.
Journal of Great Lakes Research, Vol. 8, No. 4, p. 100-110, 1982, 1 Fig., 7 Tab, 34 Ref.

Descriptors: *Phosphorus, *Phosphates, *Pollutant identification, Soluble reactive phosphorus, *Lake Michigan, Ammonium molybdate, Grand River.

Three methods for determining soluble reactive phosphorus (SRP) were compared, using lake water samples from Lake Michigan and the Grand River. Harvey's method, the ascorbic acid method, and the Chamberlain-Shapiro extraction technique differed in acid strength, exposure time, and ammonium molybdate concentration. Longer exposure times (Harvey and ascorbic methods, 9 min) often results in higher SRP values. More phosphate-P was released from bound sources in lake water with 0.16 N HCl (extraction method) than with 0.4 N HCl (Harvey method). The discrepancies among methods were not proportional to

variations in acid strength, exposure time, and molybdenum concentration but were related to differences in chemical composition of the SRP pool. Data generated by the different methods cannot be validly compared. In general, Harvey's method gave higher values than the ascorbic acid method. (Cassar-FRC)
W83-02821

SOLUBLE REACTIVE PHOSPHORUS MEASUREMENTS IN LAKE MICHIGAN: FILTRATION ARTIFACTS

National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab, S. J. Tarapchak, S. M. Bigelow, and C. Rubitschun.
Journal of Great Lakes Research, Vol. 8, No. 3, p. 550-557, 1982. 4 Tab, 25 Ref.

Descriptors: *Lakes, *Water analysis, *Phosphorus, *Filtration, Measuring instruments, *Lake Michigan, Great Lakes, Filters, *Pollutant identification.

A preliminary study was undertaken to evaluate the importance of filtration artifacts in soluble reactive phosphorus (SRP) estimation using water from southern Lake Michigan. This report demonstrates that SRP estimates can be seriously biased by variations in filtration procedures, that release of molybdate reactive PO4-P from abiotic particulate material can occur, and that filtration artifacts are partially responsible for method-specific differences in SRP estimation. Variations in vacuum pressure and filter pore size can bias estimates by approximately 100%, and variations in sample volume alone can produce nearly a twofold difference in SRP values. The best set of filtration conditions for SRP estimation cannot be specified from the analyses reported here. Leakage of molybdate-reactive PO4-P from fragile organisms will vary seasonally depending on variations in their abundance and surplus P content. Similarly, reductions in SRP caused by filter clogging will vary with the amount of debris in the water and on the density and size of P-containing particles. For routine SRP estimation it is recommended that constant vacuum pressure and sample volumes be used along with the same filter type and size. (Baker-FRC)
W83-03084

STRATIGRAPHIC EVIDENCE OF EUTROPHICATION IN AN ESTUARY

Johns Hopkins Univ., Baltimore, MD, Dept. of Geography and Environmental Engineering, G. C. Brush
Water Resources Research, Vol. 20, No. 5, p. 531-541, May, 1984, 5 Fig., 5 Tab, 41 Ref.

Descriptors: *Eutrophication, *Estuarine environment, *Stratigraphy, Algal growth, Chlorophyll, Sediments, Watershed, Fertilizers, Black River, Chesapeake Bay, Bays.

Using vertical profiles of sedimentary chlorophyll degradation products extracted from sediment cores, a comparison was made of algal productivity in Black River, an estuary of Chesapeake Bay, during the time prior to urbanization when the watershed was cultivated extensively for agriculture with productivity during the period of urbanization when secondarily treated effluent was discharged into the river from a sewage treatment plant. The productivity of the Black River was then compared to that of an adjacent estuary, Middle River, during the same time period. Vertical changes in chlorophyll degradation products showed a significant increase in algal productivity with the introduction of sewage effluent into the river. By comparison, algal product during intensive agriculture of fertilizers, was less by an order of magnitude where there was no sewage discharge from a point source. Concentrations of orthophosphorus correspond with concentrations of algal cells and chlorophyll in the water column and are greater by an order of magnitude where sewage is discharged into an estuary draining an urban-agricultural watershed than where there is no sewage. The response of the estuary to short- and long-term changes in the amount of sewage discharged is reflected by similar changes in chlorophyll production. However, chlorophyll production does not correspond with increases in the amount of fertilizers used in recent years over the amount used in the middle to late nineteenth century. (Baker-IVI)
W84-05327

TRANSPORT OF PHOSPHORUS IN SURFACE RUNOFF AS INFLUENCED BY LIQUID AND SOLID FERTILIZER PHOSPHATE ADDITION

Agricultural Research Service, Durant, OK, Water Quality and Watershed Research Lab, A. N. Sharpley and J. K. Syers.
Water, Air and Soil Pollution, Vol. 19, No. 4, p. 321-326, May 1983. 2 Fig., 1 Tab, 18 Ref.

Descriptors: *Fertilizers, *Phosphorus, *Agricultural runoff, Water pollution sources, Water pollution control, Particulates, Pastures, Surface runoff, Agricultural chemicals, Superphosphate.

The effects of superphosphate (50 kg P/ha), applied as a liquid or a solid, on transport of dissolved and particulate P in surface runoff from established pasture were evaluated using field plots and natural rainfall. An approximately 3-fold increase in the transport of both dissolved inorganic P and particulate P in surface runoff was measured in 14 weeks following fertilizer application in the solid form (2.9 and 2.9% of the applied fertilizer P, respectively) compared to the liquid application (1.0 and 1.1% of the applied fertilizer P, respectively). The application of solid fertilizer P had a more sustained effect on the concentration of both dissolved and particulate P in surface runoff. The concentration of particulate P has not returned to the prefertilizer levels some 16 weeks after the application of solid P. Although the application of liquid fertilizer P reduced losses of P in surface runoff from pasture compared to a solid application, the agronomic effectiveness of the two forms must be considered. Since solid fertilizer is more effective on pasture than liquid fertilizer (on an equal cost basis),

the use of liquid fertilizer may only be an economic method of reducing P transport in runoff from agricultural land which as a high P-loading potential. (Moore-IVI)
W84-02121

URBAN GROUNDWATER AS A POSSIBLE NUTRIENT SOURCE FOR AN ESTUARINE BENTHIC ALGAL BLOOM

Commonwealth Scientific and Industrial Research Organization, Floreat Park (Australia), Div. of Land Resources Management, P. L. Sewell
Estuarine, Coastal and Shelf Science, Vol. 15, No. 5, p. 569-576, November, 1982. 2 Fig., 2 Tab, 6 Ref.

Descriptors: *Peel Inlet, *Australia, *Estuarine environment, *Eutrophication, *Urban groundwater, Groundwater pollution, Water pollution sources, Nitrogen, Phosphorus, Wastewater pollution, Septic tanks, Groundwater movement.

The Peel Inlet in Western Australia was used to study the cause of eutrophic conditions in an estuary. In addition to large quantities of nitrogen and phosphorus (at low concentrations) entering the inlet from rivers and drains from agricultural areas, the urban contribution via groundwater was identified. The average nitrogen concentrations of urban groundwater under an area serviced with septic tank systems was 12 parts/1,000,000. Because of the nature of the soils, very few groundwater samples contained appreciable phosphorus concentrations. However, one area close to the inlet had semi-confined groundwaters with nitrogen and phosphorus concentrations as high as 100 and 0.4 parts/1,000,000 respectively. An obsolete dumping site for human excreta was also identified near the urban area, and this is suspected of having contributed to very high concentrations of nitrogen and phosphorus in groundwater which may have already reached the estuary and caused excessive algal growth. Groundwater contours showed the potential for groundwater movement from part of the urban area and also from the obsolete dumping site. (Author's abstract)
W85-00662

NITRATE/GROUNDWATER

CONSTRAINTS AND CATEGORIES OF VADOSE ZONE MONITORING DEVICES

Kaman Tempo, Santa Barbara, CA. L.G. Everett, E.W. Hoylman, L.G. Wilson, and L.G. McMillion.
Ground Water Monitoring Review, Vol. 4, No. 1, p. 26-32, Winter, 1984, 4 Fig., 2 Tab, 25 Ref.

Descriptors: *Monitoring, *Vadose zone, *Pollutant identification, Vadose water, Gravity groundwater, Groundwater, Monitoring, Water quality control, Soil properties.

A need to detect pollutants before they reach the water table has drawn interest to vadose (unsaturated) zone monitoring and brought together hydrogeologists, soil scientists and agricultural engineers who have been working in this area for years. The vadose zone is the geological profile from the ground surface to the upper surface of the principal water bearing strata. Recent studies have identified over 50 different types of vadose zone monitoring devices and methods that have optimum utility in varying hydrogeologic settings. In general, measurements made in the vadose zone are trying to define storage, transmission of liquid waste in terms of flux and velocity, and pollutant mobility. Criteria for the selection of alternative vadose zone monitoring methods are important for the development of site-specific systems. These criteria include: type of site; applicability to new, active, and abandoned sites; power requirements; depth limitations; multiple use capability; type of data collection system; reliability and life expectancy; degree of operational complexity; direct versus indirect methods; applicability to alternate media; effect on flow regime; and effect of hazardous waste on sampling or measurements. (Baker-IVI)
W84-04640

DYNAMICS OF A FERTILIZER CONTAMINATION PLUME IN GROUNDWATER

Illinois State Water Survey Div., Champaign, IL, M.J. Barcelona and T.G. Naymik.
Environmental Science and Technology, Vol. 18, No. 4, p. 257-261, April, 1984. 3 Fig., 2 Tab, 19 Ref.

Descriptors: *Groundwater pollution, *Fertilizers, Inorganic nitrogen, Mathematical model, Numerical solute transport model, Illinois.

A 2-year investigation has been conducted on the effects of a massive inorganic nitrogen fertilizer contamination of a sand and gravel aquifer in western Illinois. Groundwater monitoring in the early period of the project during near steady-state conditions disclosed that dissolved ammounium and nitrate levels exceeded 2000 and 13000 mg/L, respectively. A numerical solute transport model was applied to the system which predicted that approximately 420 days would be necessary after source removal to permit recovery of the aquifer water to near background levels within the study site. Subsequent monitoring results generally supported the model prediction and demonstrated its usefulness for predicting transport and transformations of inorganic forms of nitrogen. The chemistry and microbiology of the impact groundwater showed significant changes attendant to pollutant removal which indicate that microbially mediated processes occurred in the aquifer. (Author's abstract)
W84-04290

GROUNDWATER CONTAMINATION RESPONSE GUIDE

Volume 2, Desk reference, Final report Jun-Sep 1982. Guswa, J.H.; Lyman, W.J.; Adams, J.; Bass, J.; Brecher, A. (Little (Arthur D.), Inc., Cambridge, MA (USA)). June 1983. 325 p. (ADL-88100-00-Vol-2). NTIS, PC A14/MF A01.

This technical report documents an overview of groundwater hydrology and a current technology review of equipment, methods, and techniques used in groundwater field investigations. Numerous topics applicable to the planning, scheduling, data collection, and integration steps essential in a comprehensive field program are addressed. The report, targeted for installation engineers and managers responsible for evaluation of or response to suspected instances of groundwater contamination, consists of two volumes. Volume II: Desk Reference. A comprehensive survey of technical works resulted in this compilation of groundwater fundamentals and field investigation activities. Topical coverage ranges from hydrology basics to state-of-the-art equipment and field methods. Sufficient material is presented to acquaint the reader with basic concepts and fundamentals of groundwater and water quality issues. Numerous illustrations highlight these items. An applications-oriented review of field methods identifies equipment types and limitations. The essentials of geophysics, drilling methods, well construction, and sampling are addressed, with emphasis on integrating information in an iterative process to devise a cost-effective program. A review of contaminant transport in groundwater identifies significant parameters and physical systems of concern. Finally, a summary of groundwater treatment methods provides an options list for potential use. The report concludes with an agency address directory for water quality information and some representative cost schedules for field activities.

GROUNDWATER POLLUTION BY (OVER-)FERTILIZATION, LEGAL ASPECTS

Van Soest, J. J. (Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, Hague (Netherlands)). H20; 17: No. 22, p. 500-501, 505 (25 Oct 1984). (In Dutch).

Intensive cattle and poultry breeding creates large amounts of manure being dumped on nearby grounds because other financially attractive solutions are lacking. One of the most serious consequences is groundwater pollution by nitrates, exceeding the EEC limit value of 50 mg/l NO_3. Bills on groundwater protection and on fertilizers empowering government to put a stop on manure dumping and allowing for special measures to restrict fertilizing in groundwater protecting zones for (public) water supply are now in Parliament. Reaching acceptable results will, however, still be very difficult. Active cooperation of public water supply by controlling protecting zones will therefore be vital.

INFLUENCE OF VADOSE ZONE CONDITIONS ON GROUND WATER POLLUTION: PART I; BASIC PRINCIPLES AND STATIC CONDITIONS

Martin, J. P.; Koerner, R. M. (Drexel Univ., Philadelphia, PA). *Journal of Hazardous Materials*; 8: No. 4, p. 349-366 (May 1984).

The significance of the vadose soil zone (i.e., above a water table) is of the utmost importance in ground water pollution problems. Much of this zone is unsaturated, such that fluid movement and contaminant attenuation conditions are favorable for mitigation of aquifer pollution. The basic principles of moisture retention and the implications for leachate control are described in a state-of-the-art format. To illustrate the use of these concepts six generalized examples are presented. They cover a wide range of practical situations, including: vadose zone storage, land treatment of wastewater and sludges, waste dewatering, hydrocarbon spill storage, capillary break situations, and air and water drainage under liners. Since only the static condition is treated, a companion paper will be offered soon dealing with leachate flow and seepage in a wide range of applications.

INTERACTION BETWEEN NITROGEN FERTILIZATION, RAINFALL AND GROUND WATER POLLUTION IN SANDY SOIL

Khanif, Y.M.; Van Cleemput, O.; Baert, L. (Univ. of Ghent, Belgium). Water, Air, and Soil Pollution; 22: No. 4, 447-452 (May 1984).

A 2-year field study on the influence of N fertilization and rainfall on ground water pollution was carried out in the sandy area of Belgium. The NO_3-N and Cl content of the ground water at 0.5, 1.0, 1.5, and 2.0 m depths was monitored every two weeks on a field, grown with barley in 1980 and with maize in 1981. Turnips for cattle feed were grown in between the two crops. The total annual rainfall during the period under study was about 800 mm. The NO_3-N content at all depths was at all times above 11.3 mg dm-3, the WHO safe limit. Fluctuation of the NO_3-N content occurred mainly at 0.5 and 1.0 m. The concentration at 1.5 and 2.0 m depths was higher most of the time than at 0.5 and 1.0m. Leaching of No_3 into deeper layers occurred when there was heavy rainfall. There was no important loss of NO_3-N through denitrification at 1.5 and 2.0 m depths.

INVESTIGATION OF SOURCES OF GROUNDWATER NITRATE CONTAMINATION IN THE BURBANK — WALLULA AREA OF WASHINGTON, U.S.A

Nebraska Univ., Lincoln, NE, Conservation and Survey Div., R.F. Spalding, M.E. Exner, C.W. Lindau, and D. W. Eaton.
Journal of Hydrology, Vol. 58, No. 3/4, p. 307-324, September, 1982, 5 Fig., 2 Tab, 48 Ref.

Descriptors: *Water pollution sources, *Groundwater pollution, *Nitrates, *Burbank, *Wallula, *Washington, Water quality, Agricultural wastes, Leachates, test wells, Walla Walla county.

During the past decade the increased emphasis on the quality of drinking water has resulted in expanded groundwater for drinking. The most commonly reported chemical contaminant is nitrate. During the fall and early winter of 1980, groundwater samples were collected from 38 public supply and domestic wells in the Burbank Wallula area of Washington. Groundwater nitrate-nitrogen (NO3-N) concentrations ranged from 3.9 to 32 mg/l and averaged 10.5 mg/l. Nitrogen isotope composition (delta N-15) of the NO3-N ranged from + 1.3 to + 16.0 0/00 and averaged + 4.1 0/00. The preponderance of low delta N-15 values suggests that agricultural leachates (from oxidation of soil humus or use of nitrogen fertilizers) are the primary source of contamination for the area. Fourteen of the 38 wells were sampled at least twice in a 4-month period. The relative invariability in NO3-N levels and delta N-15 in these wells suggests little or no temporal change in either the source or the magnitude of the source. Two additional samples collected in May 1981 from monitoring wells on the perimeter of a cropped field spray-irrigated with cattle waste from an anaerobic lagoon had delta N-15 values for the NO3-N of + 12.0 and + 18.7 0/00, respectively. The high delta N-15 values in these wells indicate that the NO3-N is predominantly derived from animal waste. (Murphy-IVI)
W84-04853

LAND APPLICATION OF SEWAGE SLUDGE WITH REGARD TO CROPPING SYSTEMS AND POLLUTION POTENTIAL

Cook Coll., New Brunswick, NJ, A.J. Higgins.
Journal of Environmental Quality, Vol. 13, No. 3, p. 441-448, July-September, 1984. 6 Fig., 5 Tab, 26 Ref.

Descriptors: *Sludge disposal, *Land disposal, *Water pollution sources, Waste disposal, Groundwater pollution, Heavy metals, Soil types, Fertilizers, Salts, Nitrates, Corn, Rye.

Potential benefits of using sewage sludge on Sassafras sandy loam soil, typical of eastern coastal plain soils, as a soil conditioner and fertilizer for the production of agricultural crops were investigated. Primary objectives were to deter-

mine the potential for groundwater pollution from disposal of high rates of sludge into Sassafras sandy loam soil, the accumulation of salts and heavy metals in soil from sludge application, the accumulation of heavy metals in plant tissue from sludge application, and the maximum sludge application rate based on groundwater contamination. Sludge application of 22.4 Mg of dry solids/ha on Sassafras sandy loam soil, or other similar sandy loam soils, is the upper limit to ensure protection of the groundwater quality. Annual applications of 44.8 Mg dry solids/ha resulted in gross contamination of the groundwater by nitrate-nitrogen and other salts. No contamination of the groundwater by heavy metals was detected at either rate. Fecal coliform levels were low throughout the duration of the study. Zinc and copper accumulated in the A soil horizon, but no accumulation occurred in the B horizon. Corn and rye yields were greatly enhanced by the addition of sludge but there was little difference in yield between the sludge loading rates. Uptake of heavy metals in the corn and rye occurred in response to sludge application. Zinc was the only metal that consistently appeared at levels above the control. (Baker-IVI)
W85-01291

LONG-TERM TRENDS IN NITRATE CONCENTRATION IN IOWA WATER SUPPLIES

Iowa Univ., Iowa City, IA, State Hygienic Lab,D. B. McDonald, and R. C. Splinter.

Journal of the American Water Works Association, Vol. 74, No. 8, p. 8,437-440, August, 1982. 4 Fig., 3 Tab, 4 Ref.

Descriptors: *Nitrate, *Fertilizers, *Anhydrous ammonia, *Groundwater pollution, *Rivers, Water pollution, Water pollution sources, Agricultural runoff, Agricultural chemicals, Agricultural watersheds, Water quality, Shallow wells, Deep Wells, *Iowa.

Increases in nitrate concentrations in surface waters and shallow wells were found in long-term water quality studies in Iowa. High nitrate (more than 45 mg/liter) values were common during periods of relatively low river flow in the fall and winter. Nitrate infiltration of shallow aquifers was also evident from shallow well samples. The increased levels of nitrate were not unexpected because of the steady increase in the use of anhydrous ammonia in Iowa. Groundwater from deeper wells had much lower nitrate levels than groundwater from shallow wells. Nitrate contamination has not yet reached the deeper aquifers. The future of nitrate contamination has not yet reached the deeper aquifers. The future of nitrate contamination in the area depends upon the use of fertilizer and other farming practices. (Small-FRC)
W83-02711

MIGRATION OF CONTAMINANTS IN GROUNDWATER AT A LANDFILL: A CASE STUDY: 1. GROUNDWATER FLOW AND PLUME DELINEATION

Waterloo Univ. (Ontario). Dept. of Earth Sciences, D.S. MacFarlane, J.A. Cherry, R.W. Gillham, and E.A. Sudicky.

Journal of Hydrology, Vol. 63, No. 1-2, p. 1-29, May, 1983. 9 Fig., 1 Tab, 31 Ref.

Descriptors: *Pollutant migration, *Groundwater pollution, *Landfills, *Leachates, Chloride, Sulfate, Conductance, Water temperature, Water table mounding, Permeability coefficient, Groundwater movement, Plumes, Groundwater recharge, Mixing, Dispersion.

A landfill-derived contaminant plume with a maximum width of 600 m, a length of 700 m and a maximum depth of 20 m in an unconfined sand aquifer was delineated by means of a monitoring network that includes standpipe piezometers, multilevel point-samplers and bundle-piezometers. The extent of detectable contamination caused by the landfill, which began operation in 1940 and which became inactive in 1976, was determined from the distributions of chloride, sulfate and electrical conductance in the sand aquifer, all of which have levels in the leachate that are greatly above those in uncontaminated groundwater. The maximum temperature of groundwater in the zone of contamination beneath the landfill is 12 C, which is 4-5 C above background. The thermal plume in the aquifer extends 150 m downgradient from the center of the landfill. A slight transient water table mound exists beneath the landfill in the late spring and summer in response to snowmelt and heavy rainfall. Beneath the landfill, the zone of leachate contamination extends to the bottom of the aquifer, apparently because of transient downward components to hydraulic gradient caused by the watertable mound and possibly because of the higher density and lower viscosity of the contaminated water. Values of hydraulic conductivity, which show variations due to local heterogeneity, were obtained from slug tests of piezometers, from pumping tests and from laboratory tests. Because of the inherent uncertainty in the aquifer parameter values, the 38-year frontal position of the plume calculated using the Darcy equation with the assumption of plug flow can differ from the observed frontal position by many hundreds of meters, although the use of mean parameter values produces a close agreement. The width of the plume is large relative to the width of the landfill and can be accounted for primarily by variable periods of lateral eastward and westward flow caused by changes in water-table configuration due to the variable nature of recharge. Northward from the landfill, the vertical thickness of the plume decreases and the top of the plume is farther below the water table. The thickness of the zone of uncontaminated water downflow from the landfill increases. Because dispersion in the vertical direction is weak, there is very little missing between the overlying zone of recharge water and the con-

taminant plume. Concentration profiles are irregular beneath and near the landfill and become smooth downgradient where the maximum concentrations are much less than those beneath the landfill. These features are attributed to a strong influence of longitudinal dispersion. The plume passes beneath a small shallow stream near the landfill without significant influence on the stream. (Author's abstract)
W84-01684

MIGRATION OF CONTAMINANTS IN GROUNDWATER AT A LANDFILL: A CASE STUDY: 2. GROUNDWATER MONITORING DEVICES

Waterloo Univ. (Ontario). Dept. of Earth Sciences, J.A. Cherry, R.W. Gillham, E.G. Anderson, and P.E. Johnson.
Journal of Hydrology, Vol. 63, No. 1-2, p. 31-49, May, 1983. 5 Fig., 13 Ref.

Descriptors: *Groundwater pollution, *Monitoring, *Sampling, Plumes, Piezometers, Landfills, Leachates, Water quality, Water table, Sand aquifers, Networks.

Six types of devices for groundwater monitoring were used on an experimental basis in the investigation of the plume of contamination in the unconfined sandy aquifer at the Borden landfill. These include: standpipe piezometers, water-table standpipes, an augerhead sampler, suction-type and positive-displacement-type multilevel point-samplers, and bundle-piezometers. With the exception of the first two, each of these devices provides a means of obtaining vertical sample profiles of groundwater from a single borehole. The auger-head sampler, which is a device that is attached to the cutting head of conventional continuous-flight hollow-stem augers, yields amples from relatively undistributed aquifer zones as the augers are advanced downward in the borehole from one depth of sampling to another. This method is a rapid means of acquiring water-quality profiles for mapping the distribution of a contaminant plume. The other three profiling devices can be used to establish permanent networks for groundwater-quality monitoring. A suction-type multilevel sampler consists of twenty or more narrow polyethylene or polypropylene tubes contained in a PVC casing that is capped at the bottom. Each tube extends to a different depth and is attached to a small screened sampling point that extends through the casing to draw water from the aquifer when suction is applied. A positive-displacement multilevel sampler is similar except that each sampling point is connected to a positive-displacement pumping device located inside the PVC casing adjacent to the screen. Use of the suction-type multilevel sampler is limited to zones where the water table is less than the suction-lift depth of 8 or 9 m. The positive-displacement sampler can be used even if the water table is at a much greater depth. A bundle-piezometer consists of 1.2-cm O.D. flexible polyethylene tubes, each with a short screened section at the bottom, fastened as a bundle around a semirigid center-piezometer constructed of thickwalled 2-cm O.D. PVC pipe. In shallow water-table areas water is withdrawn from each of the tubes and from the PVC piezometer by suction. In areas with a deep water table, samples are obtained by bailing with a narrow tube with a check valve on the bottom or by displacement using a double or triple-tube gas-drive sampler. The positive-displacement multilevel sampler or use of the gasdrive samplers in the bundle-piezometers provide the best opportunities for collecting samples that can be filtered and have preservatives added without the water being influenced excessively. Networks of these three types of devices for multilevel groundwater monitoring were installed in the Borden aquifer by means of hollow stem augers. The devices are particularly well suited for use in aquifers composed of cohesionless sand or gravel that have little or no clay and groundwater flow that is primarily horizontal. When 8-cm diameter hollow-stem augers are used, as many as either polyethylene tubes are included conveniently in each bundle-piezometer. If augers with a large hollow-stem are used, more tubes can be assembled in each bundle. (Author's abstract)
W84-01685

MOVEMENT OF NITROGEN SPECIES THROUGH THREE SOILS BELOW SEPTIC FIELDS

Texas A and M Univ., College Station, TX, Dept. of Soil and Crop Sciences, K.W. Brown, K.C. Donnelly, J.C. Thomas, and J.F. Slowey.
Journal of Environmental Quality, Vol. 13, No. 3, p. 460-465, July-September, 1984. 5 Fig., 3 Tab, 20 Ref. EPA grant R802955-02-0.

Descriptors: *Septic wastewater, *Nitrogen, *Leaching, *Groundwater pollution, Wastewater disposal, Ammonium, Nitrates, Soil properties, Soil types, Sand, Clay.

Septic fields designed to meet current standards have the potential to saturate the available exchange sites of a sandy soil with ammonia-nitrogen. After saturation, the ammonia-nitrogen moves downward with the leachate water. Downward ammonia-nitrogen movement was measured at 100 cm/yr in Norwood sandy clay and Miller clay soils. During dry periods when the soil became aerated, some of the ammonia-nitrogen oxidized to nitrate-nitrogen which came out in the leachate water. Soil solution measurements indicated that these transformations occurred about 75 cm horizontallly away from the septic line near the wetting front. After 2 years of application, total N measurements indicated an accumulation of N directly under the septic line. Values as high as 1007 micro g/g were measured. Total N losses ranged from 0.45 to 2.19% of that applied but would be expected to rise sharply in future years since the sandy loam soil had become saturated with ammonia-nitrogen. When a septic field dries out during summer or is abandoned, much accumulated N will be converted to nitrate-nitrogen which is likely to leach to the groundwater. (Baker-IVI)
W85-01293

NITRATE CONTAMINATION OF GROUNDWATER ON THE OLD MISSION PENINSULA CONTRIBUTION OF LAND RESHAPING AND SEPTIC-DRAINFIELDS

Michigan State Univ., East Lansing, MI, Dept. of Crop and Soil Science, B.G. Ellis.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-108340. Price codes: A03 in paper copy, A01 in microfiche. Completion Report, March 1982. 33 p., 2 Fig., 17 Tab, 12 Ref, 1 Append. OWRT A-119-MICH(1), 14-34-0001-1124.

Descriptors: *Nitrates, *Groundwater pollution, *Land forming, *Drainage effects, *Water quality standards, Land development, Subsurface drainage, Groundwater, Land use, Landscaping, Terracing, Septic sludge, Septic wastewater, Drainage water, Catchment areas, Drinking water, Soil porosity.

Research was carried out to determine the concentration of nitrate nitrogen in the soil with depth as affected by reshaping land surfaces, as well as its concentration leading from setic drainfields, in order to examine the movement of nitrate through soils as a result of reshaping soil surfaces and using septic drainfields. In both cases, nitrate values exceeding the drinking water standard were observed. However, the nitrate increases as a result of land reshaping were not considered to be a major source of groundwater contamination, since, in the worst case (heavy fill of top soil to a depth of 10 feet or more) nitrate should decrease with time. Septic systems were found to give 20-40 ppm nitrate nitrogen during all seasons of the year, which is 2-4 times the drinking water standard. This is expected to represent a serious contamination source, since it is not expected to be diluted by more than about half for the lot sizes in many of the Peninsula subdivisions. It may also become more of a problem in the future as nitrate content in the well water begins to rise. Nitrate nitrogen in deep profile soil samples (for reshaped land) and samples from lysimeters (for septic drainfields) was extracted, reduced to nitrite, and analyzed colorimetrically on an automatic analyzer. (Zielinski-MAXIMA)
W83-00228

NITRATE CONTAMINATION OF SUBSURFACE WATERS IN AN URBANIZING AREA

Case Western Reserve Univ., Cleveland, OH, Dept. of Geological Sciences, G. Matisoff, J.M. Inglis, and W.R. Kelly.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-159748, Price codes: A03 in paper copy, A01 in microfiche. Water Resources Center Report OSURF No. 713266, Ohio State Univ., Columbus, September, 1983. 29 p., 6 Fig., 1 Tab, 24 Ref. Project No. OWRT A-066-OHIO (1).

Descriptors: *Groundwater, *Nitrates, *Chlorides, *Computer models, *Solute transport, Unconfined aquifers, Groundwater pollution, Groundwater level, Groundwater recharge, Groundwater movement, Geohydrology, Model studies, *Ohio, Lake County, Water pollution sources, Path of pollutants, Groundwater flow model, Solute transport model, Road salt runoff, Hydrogeology.

The groundwater system in northern Perry Township in Lake County, Ohio is a shallow, unconfined aquifer consisting of glacial lake beach deposits and less permeable lacustrine plain deposits. Groundwater flow is generally from south to north, but strong, local variations are caused by northward flowing streams. The areal distributions of chloride and nitrate suggest that recharge is derived from local infiltration. Groundwater flow and solute transport models were used to simulate flow and pollutant transport in the study area under hydrologic steady-state rates of 0-4 feet per day which indicate that in excess of 27 years are required to obtain chemical steady-state. The simulations also demonstrate that nitrate loading must occur in more than one cultivated field and that a commercial nursery is not the sole source of contamination. Road salt run-off easily infiltrates the aquifer and can be readily described by the model. The results underscore the susceptibility of shallow aquifers to even modest surficial chemical contamination. In such cases it may be necessary to implement some types of land use control or to restrict the development of groundwater.
W84-04227

NITRATE DISTRIBUTION IN THE GROUND WATER OF THE ALLISTON REGION OF ONTARIO, CANADA

York Univ., Toronto (Ontario). Dept. of Geography, A.R. Hill, Ground Water, Vol. 20, No. 6, p. 696-702, November-December, 1982. 4 Fig., 1 Tab, 16 Ref.

Descriptors: *Groundwater pollution, *Nitrates, *Fertilizers, *Ontario, *Alliston, Path of pollutants, Agriculture, Wells, Water pollution sources.

Analysis of groundwater samples from wells and springs indicates that several major areas of nitrate contamination occur within the shallow aquifer near Alliston, Ontario. Nitrate-N concentrations under potato fields often exceed 10 mg/l, whereas concentrations of less than 1 mg/l are characteristic of groundwater under areas of forest and permanent pasture. Regression analysis revealed a significant positive correlation between nitrate-N concentration in groundwater and the average rate of fertilizer nitrogen application in the 1977-80 period. A significant positive association between ground water chloride concentration and rates of potassium chloride fertilizer application together with consistent Cl/NO3-N ratios in ground water under potato fields also suggests that fertilizers are the major source of nitrate in the aquifer. Eight wells located adjacent to heavily fertilized potato fields had very low nitrate-N concentrations. In contrast to the majority of wells, these

8 penetrated to more than 20 ft below the water table. The likelihood that low nitrate-N concentrations occur in the deeper portion of the aquifer requires further study. If the presence of a widespread zone of low nitrate-N concentrations could be confirmed in the Alliston area, it may be possible to alleviate problems of high nitrate levels in domestic water supplies by constructing wells which extend to a greater depth below the water table. (Baker-IVI)
W85-00347

NITRATE IN BRITISH WATERS

National Water Council, London (England), R.J. White.
Aqua, No. 2, p. 51-57, April, 1983. 6 Fig., 27 Ref.

Descriptors: *Nitrate, *Water quality control, Great Britain, Standards, Water pollution sources, Drinking water, Human diseases, Methemoglobinemia.

Health risks and water quality standard are discussed for nitrate. The origin of nitrate in water is reviewed as a background to rising concentrations in both rivers and groundwater. The identified health risk which was noted in the 1974 IWSA International Standing Committee on Water Quality and Treatment Report was methemoglobinemia. Since that time the incidence of this problem has become rarer in Great Britain. Nitrate concentrations in both rivers and groundwater sources have been increasing and the problems could become worse before equilibrium is reached. The principal cause is changes in farming practices to enhance agricultural productivity. Opportunities for controlling nitrate sources are limited. Water treatment processes have been developed with a view to keeping nitrate concentrations in public supplies below 50 mg/l NO3. The visibility of ion exchange has been established and problems in biological denitrification are being overcome. There is a possibility of substantial expenditure being required to reduce nitrate concentration but steps to deal with the problems in public supplies are well in hand. In Britain about 99% of the population receives water from the public supply systems. The most significant risks attached to nitrate lie with the small minority who rely on private supplies from shallow wells. (Baker-IVI)
W84-01456

NITRATE IN WATERS FOR HUMAN CONSUMPTION: THE SITUATION IN FRANCE (1979-1981). A STUDY BY THE FRENCH MINISTRY OF HEALTH, (TENEUR EN NITRATE DES EAUZ DESTINEES A LA CONSOMMATION HUMAINE: LA SITUATION EN FRANCE (1979-1981). ETUDE REALISEE PAR LE MINISTERE DE LA SANTE FRANCAIS: CADRE DE L'ETUDE).

Aqua, No. 2, p. 74-78, April, 1983. 2 Fig., 7 Tab.

Descriptors: *Nitrates, *Groundwater, *Drinking water, *Regulations, France, Agricultural runoff, Well water, Groundwater contamination.

The French Ministry of Health has issued instructions on the attitude to be taken in regard to the presence of nitrate in drinking water. A survey was performed which revealed that 81% of the population has nitrate levels less than 25 mg/l and 96% to 98% has levels less than 50 mg/l in their drinking water supplies. Out of 53 million people approached in the survey, 280,000 at most have a water supply which exceeded 100 mg/l of nitrate at least once in the last three years. Out of the 20,00 distribution units surveyed about 1000 had nitrate above 50 mg/l and 61 only were about 100 mg/l. Most of the high nitrate areas were in the North and West of metropolitan France. Most of the high nitrates are found in groundwater, and most of the wells affected were in highly developed agricultural areas. Treatment by activated carbon is very effective but costly particularly because of regeneration whose frequency depends on speed of saturation of the carbon and thus on its place in the sequence of treatment. Based on a study of the physical chemical characteristics of aluminas suitable for industrial use, it is concluded that activated alumina cannot fulfil the role of activated carbon for drinking water quality control. However, because of the specific absorption capacity and the ease of regeneration the use of activated alumina for the removal of organics is a subject which must be pursued. The possibility of specific activation during alumina preparation or alumina-carbon methods or alumina in oxidation treatment should be considered. (Baker-IVI)
W84-01460

NITRATE LEACHING AS INFLUENCED BY WATER APPLICATION LEVEL AND NITRIFICATION INHIBITORS

Agricultural Research Service, Ames, IA, D.R. Timmons.
Journal of Environmental Quality, Vol. 13, No. 2, p. 305-309, April-June, 1984. 4 Fig., 4 Tab, 19 Ref.

Descriptors: *Nitrates, *Irrigation practices, *Nitrification inhibitors, Nonpoint pollution sources, Leaching, Water pollution sources, Nitrapyrin, Terrazole, Groundwater pollution, Fertilizers, Supplemental irrigation.

The effects of water application level and nitrification inhibitors on NO3-N leaching from a sandy loam soil were evaluated using soil columns and nonweighing field lysimeters. In soil columns and (297 mm diam. by 1.2 m deep) fertilized with 224 kg N/ha, addition of the nitrification inhibitor nitrapyrin (2-chloro-6(trichloromethyl) pyridine) reduced NO3-N leaching losses by 51 and 30 kg/ha, respectively, for the 12.7- and 38.1-mm weekly water application levels. Both nitrapyrin and Terrazole (5-ethoxy-3-trichloromethyl-1,2,4-thiadiazole) inhibitors were equally effective in reducing total NO3-N leaching losses from soil columns after 100 d for the 38.1-mm water application level. The change in flow-weighted NO3-N concentration due to use of nitrification inhibitors was about -0.4 to -1.0 mmol/L. Annual NO3-N leaching losses measured at the 1.2-m depth in field lysimeters cropped

with corn (Zea mays L.) over a 3-yr period averaged about 12 kg/ha less (7%) for nitrapyrin-coated area. The results were not consistent since nitrapyrin reduced NO3-N leaching during the growing season by 12 and 17% for 2 of the 3 year and post season leaching by 35% for 1 year. The change in flow-weighted NO3-N concentration (3-yr avg) due to nitrapyrin was -0.4, -1.5, and +0.9 mmol/L, respectively, for the growing season, post season, and pre-emergence periods. Nitrification inhibitors may help to minimize nonpoint-source pollution on sandy soil where supplemental irrigation is used by reducing and/or delaying NO3-N leaching particularly during the growing season when N is utilized by plants. (Author's abstract)
W84-05122

NITRATE REMOVAL FOR SMALL PUBLIC WATER SYSTEMS, TECHNICAL REPORT (PB-84-193044)

(SMC Martin, Inc., Valley Forge, PA (USA)). Jun 1983, 93 p. NTIS, PC A05/MF A01.

This Handbook for Nitrate Removal has been prepared to aid water utility owners, engineers, operators, and municipal managers in understanding and dealing with excessive nitrate levels in their water supply. It is intended to be used for defining the problem, developing or evaluating proposed solutions, and explaining to water consumers why nitrates are controlled and what the approximate costs of control will be. This handbook is designed as a technical guide to nitrate removal for those smaller size systems that have decided that nitrate control is desirable. This document contains no regulatory policy and does not obligate systems to use any treatment or nontreatment technique to reduce nitrate concentrations.

NITRATE TRENDS IN THE COASTAL PLAIN AQUIFER OF ISRAEL

Israel Water Commission, Tel Aviv. Water Pollution Control Unit, Y. Kanfi, D. Ronen, and M. Magaritz.
Journal of Hydrology, Vol. 66, No. 1-4, p. 331-341, October, 1983. 6 Fig., 2 Tab, 16 Ref.

Descriptors: *Nitrates, *Coastal aquifers, *Israel, Mineralization, Water pollution sources, Groundwater pollution.

The variation in the average concentration of nitrates in the Coastal Plan aquifer of Israel was determined. Sampling was performed on 932 pumping wells which were distributed throughout the aquifer, comprising 60% of all the pumping wells in the aquifer. Sampling was done in the summer of 1973 and again in the summer of 1981. In 1973 the average nitrate concentration was 52 mg/l, which increased at a rate of 0.13 mg/l/year. The rates of increase of the average nitrate concentration were 1.45 mg/l/year in the 1950s and 0.56 mg/l/year during the 1960s. There is some evidence which indicates that the rate of nitrate concentration was even higher for the period 1920-1950. The initial high rates of nitrate increase were probably due to mineralization of about 400 kg N per 1000 sq m released when cultivation of virgin soils in the Coastal Plain began during the first half of this century. The reduction in the rate of nitrate increase indicates that the nitrogen system in the aquifer may be approaching a new steady state. (Baker-IVI)
W84-02475

NITRATES CONCENTRATION REDUCTION IN DRINKING WATER: EXTRA DETAILS ON BIOLOGICAL TREATMENTS (REDUCTION DES TENEURS EN NITRATES DANS LES EAUX DE CONSOMMATION: LE POINT SUR LES TRAITEMENTS BIOLOGIQUES)

J.M. Philipot, J. Sibony, G. Martin, and G. Blecon.
Aqua, No. 2, p. 61-67, April, 1983. 4 Fig., 6 Tab, 14 Ref.

Descriptors: *Water treatment, *Nitrates, *Drinking water, Denitrification, Heterotrophic bacteria, Filtration, Biological treatment, Anaerobic treatment, Organic compounds.

The presence of nitrates in drinking water is a subject of concern for the consumer. In France the Supreme Health Authority has given a favorable opinion on the development of a biological process. This method uses the properties of some bacteria in anoxic conditions, to oxidize a carbonaceous substrate, i.e. ethanol, and to reduce the nitrates to gaseous nitrogen. It is the heterotrophic pathway. High yields are obtained by cell-fixation of denitrifying bacteria on a specific mineral medium. A post treatment including an aerated filtration of G.A.C. and a sand filtration is achieved in one step through a BIOCARBONE filter: the nitrate content of the raw water is then reduced to 25 mg/l; in the same way, organics and micropollutants, often associated with nitrate pollution, are removed. Another biological treatment will soon be available; it uses the autotrophic pathway of biological denitrification. A reduced mineral substrate, i.e. granular sulfur, is used for nitrate reduction to gaseous nitrogen. A mixed bed of calibrated grains of sulfur and calcium carbonate enhances the denitrification rate. Figures are given of the results of both processes with different kinds of raw water. (Author's abstract)
W84-01458

NITRATES IN DRINKING WATER: A PROBLEM WITHOUT SOLUTIONS

Tils, H.; Hellekes, R., Kommunalwirtschaft; No. 6, p. 182-185 (Jun 1984). (In German)

In many areas of the Federal Republic of Germany the utilization of land has caused an increase in dissolved materials in water. For years, the water boards have, in particular been warning about the increase in nitrate concentration in ground water and trying to find ways of reducing the nitrate concentration. Technical, agricultural and official measures can be employed to solve the problem of high nitrate concentrations. A possibility for the short term would be the provision of replacement water deficient in nitrates by opening new water sources or a new water board. Purification plants — ion exchange, biological processes, osmosis — will probably not be available until the medium term, when research projects currently being carried out have been evaluated in one to two years. These cost-intensive treatments are, however, retrospective measures of repair. The most sensible solution to the nitrate problem must be to tackle the roots. Numerous publications and agricultural recommendations show that farmers can reduce nitrate erosion into groundwater without any economic intervention by farming in a way that conserves water.

ORGANIC CONTAMINANT BEHAVIOR DURING RAPID INFILTRATION OF SECONDARY WASTEWATER AT THE PHOENIX 23RD AVENUE PROJECT

Stanford Univ., CA. Dept. of Civil Engineering, E.J. Bouwer, P.L. McCarty, H. Bouwer, and R. C. Rice.
Water Research Vol. 18, No. 4, p. 463472, 1984. 5 Fig., 8 Tab, 26 Ref.

Descriptors: *Fate of pollutants, *Rapid infiltrations, *Groundwater recharge, *Organic compounds, *Phoenix, *Arizona, Water reuse, Wastewater renovation, Volatilization, Biodegradation, Sorption, Halogenated organic compounds, Aliphatic compounds, Aromatic compounds, Groundwater pollution.

Movement of trace organic pollutants during rapid infiltration of secondary wastewater for groundwater recharge was studied at the 23rd Avenue Rapid Infiltration Project in Phoenix, Arizona. Samples of the wastewater applied to the spreading basins and of renovated water taken from monitoring wells were characterized for priority pollutants and other specific organic compounds using gas chromatography/mass spectrometry. The concentrations of organic constituents were affected by volatilization, biodegradation and sorption process. Nonhalogenated aliphatics and aromatic hydrocarbons exhibited concentration decreases of 59-99 degrees, during soil percolation. Halogenated organic compounds were generally removed to a lesser extent. Concentrations of trichloroethylene, tetrachloroethylene, and pentachloroanisole appeared to be significantly higher in the renovated water than in the basin water, reasons for this behavior remain unclear. Many organic contaminants were detected in the groundwater indicating such systems should be designed to localize contamination of the aquifer. Chlorination of the wastewater had no significant effect on contaminations and types of trace organic compounds. (Author's abstract)
W84-04353

ORIGIN OF NITRATES IN GROUNDWATER OF THE BUNZ VALLEY (WOHER STAMMEN DIE NITRATE IM GRUNWASSER DES BUNZTALES)

Kanton Aargau, Aarau (Switzerland). Informations-und Dokumentations-dienst, W. Fricker. Wasser, Energie, Luft, Vol. 75, No. 3, p. 75-77, 1983.

Descriptors: *Groundwater pollution, *Nitrates, *Bunz valley, *Switzerland, Water pollution sources, Animal wastes, Fertilizers, Sludge disposal, Water pollution control, Water treatment.

A study was ordered in 1975 to determine the origins of nitrates in the groundwater of the Bunz valley, Aargau Canton, Switzerland. This followed the discovery of increasing nitrate concentrations in groundwater wells in the region between 1970 and 1975, occasionally exceeding the Swiss maximum permissible level of 40 mg/1. The Bunz valley covers 8,600 ha, of which 53% is used agriculturally. The main source of nitrate was the agricultural application of nitrogen to the soil, which totals about 430 kg/yr. Half of this is applied as direct manuring (73.8% farmyard manure, 23.8% mineral fertilizer and 2.4% sludge from wastewater treatment plants). About 2.3% of this appears in runoff as nitrate. Increased nitrate concentrations can be expected when a large proportion of land is fallow, when fallow land is fertilized with nitrogen at times other than the growing season, and when fertilization is performed at the incorrect time. Short-term measures to combat this are to educate farmers in correct fertilization and planting practices, to institute fertilization restrictions in ground water conservation areas, and to reduce nitrates in drinking water by ion exchange or reverse osmosis. Intermediate measures are to dilute nitrate-rich wells with water from nearby wells with low nitrate levels and to cultivate only those crops (grass alone in extreme cases) that prevent excessive runoff of nitrates. (Gish-IVI)
W85-01856

POLLUTION OF DRINKING WATER WITH NITRATE

Bremer Umweltinstitut fuer die Analyse und Bewertung von Schadstoffen (Germany, F. R.). B. Gabel, R. Kozicki, U. Lahl, A. Podbielski, and B. Stachel.
Chemosphere, Vol. 11, No. 11, p. 1147-1154, 1982. 2 Fig., 2 Tab, 18 Ref.

Descriptors: *Nitrates, *Manure, *Drinking water, Water pollution sources, Agriculture, Fertilizers, *Federal Republic of Germany, *Nonpoint pollution sources, Path of pollutants, Fate of pollutants.

High nitrate levels in drinking water in West Germany and intensive use of animal manures on agricultural land were highly correlated. Maps depict the areas of heavily cultivated land high nitrate levels in drinking water supplies, some over 250 mg per liter. The higher nitrate levels are found around Hamburg, Hanover, south of Bremen,

west of Wasen and Cologne, around Frankfurt, north of Stuttgart, northeast of Munich, in the Moselle Valley, and in several other regions. Only a few small areas of highly intensive cultivation were found without high nitrate concentrations in drinking water. (Cassar-FRC)
W83-02646

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POTENTIAL AQUIFER POLLUTION FROM NITRATE LEACHING FOLLOWING THE PLOWING OF TEMPORARY GRASSLAND

Lincoln Coll. (New Zealand). Dept. of Soil Science. K.C. Cameron and A. Wild.
Journal of Environmental Quality, Vol. 13, No. 2, p. 274-278, April-June, 1984. 2 Fig., 3 Tab, 14 Ref.

Descriptors: *Nitrate, *Leaching, *Plowing, *Groundwater pollution, *England, Water pollution sources, Grasslands, Soil solution, Mineralization, Chalk soils.

Investigation of the amounts and concentrations of nitrate released following the plowing of temporary grassland confirmed that this practice forms a potential major source of NO3-N pollution of aquifers. Estimates were made of the amounts and concentrations of NO3(-) released due to mineralization following the fall plowing of temporary grassland at three sites on Chalk soils, and that rate of leaching of this NO3-N by winter rainfall. Large amounts of NO3(-) (100 kg N/ha) are released due to fall mineralization and the amount appears to be related to the soil total N content rather than age of the temporary grass. At two sites, losses of NO3(-) due to winter leaching to depths below the 90-cm depth were about 100 kg N/ha over two winters and about 25 kg n/ha over one winter at the third site. High concentrations of NO3(-) in soil solution, in excess of WHO limits, are found to move out of the soil into the unsaturated zones of the Chalk aquifers. The average rate of leaching through the Chalk soils studies in southern England was about 1 m/yr. It is recommended that winter rather than spring cereals be planted as soon as possible in order to minimize the leaching loss of NO3(-). (Moore-IVI)
W84-05120

REMOVAL OF NITRATE, SULFATE AND HARDESS FROM GROUNDWATER BY ION EXCHANGE

Iowa State Water Resources Research Inst., Ames, IA, J.L. Musterman, D.W. Swailes, T.J. Laford, and D.A. Bergo.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-220335, Price codes: A06 in paper copy, A01 in microfiche. Completion Report No. 112, February 1983. 111 p., 30 Fig., 13 Tab, 46 Ref. OWRT A-075-IA(1), 14-34-0001-0117.

Descriptors: *Nitrates, *Sulfates, *Hardness, Mathematical models, Design criteria, Drinking water, *Ion exchange, *Water treatment, Resins, Anion resins, Groundwater.

Removal of nitrate, sulfate and hardness with strong base resins is possible. The purpose of this study was to determine the effects of nitrate and sulfate loading on regeneration efficiency of strong base anion exchange resins and to develop design criteria for nitrate and sulfate removal. An empirical model to predict regeneration requirements for strong base anion exchange resins for nitrate removal was developed and verified. Extensive laboratory test using various exchange resins were used to verify the model. A second model was developed to predict the length of time for exhaustion of the resin as a function of loading. Several anion resins were evaluated for nitrate removal. No significant difference in the regeneration efficiencies between resins was observed.
W83-03290

SOURCES OF NITRATE IN GROUNDWATER IN A SEWERED HOUSING DEVELOPMENT, CENTRAL LONG ISLAND, NEW YORK

Geological Survey, Syosset, NY, Water Resources Div. W.J. Flipse, Jr., B.G. Katz, J.B. Lindner, and R. Markel.
Ground Water, Vol. 22, No. 4, p. 418-426, July-August, 1984. 3 Fig., 5 Tab, 31 Ref.

Descriptors: *Nitrates, *Water pollution sources, *Long Island, *New York, *Groundwater pollution, Fertilizers, Animal wastes, Ammonium, Organic nitrogen, Wastewater pollution.

Nitrate concentrations in ground water on Long Island, New York, have increased markedly in the last 30 years. A significant amount of this increase has been attributed to lawn and garden fertilizers in addition to cesspool and septic-tank discharges. The increase in nitrate concentration is of particular concern in the central and eastern part of the island, where ground water is the sole source of drinking water. Ground water samples were collected from 14 wells screened near the water table in the sewered Twelve Pines housing development constructed in Medford, Suffolk County, in 1970. Samples were collected during 1972-79 and analyzed for total ammonium, organic nitrogen, and nitrate. Statistical analyses indicate that concentrations of nitrate-nitrogen in water from 10 of the wells increased significantly during 1972-79; those in water from the other four wells did not. Nitrogen loads were estimated to be 2,300 kg/yr from fertilizers, less than 80 kg/yr from irrigation water, 200 kg/yr from animals, and less than 670 kg/yr from precipitation. Leakage from sewers was considered negligible. Nitrate-nitrogen isotope ratios also suggest that the greatest source of nitrogen is from cultivation sources (either mineralized soil nitrogen or fertilizers) rather than human or animal wastes. (Author's abstract)
W85-01529

VARIATIONS IN GROUNDWATER QUALITY WITH DROUGHT

Kansas Water Resources Research Inst., Manhattan, KS, D.O. Whittemore, G.A. Marotz, and K.M. McGregor.
Available from the National Technical Information Ser-

vice, Springfield, VA 22161 as PB83-208298, Price codes: A04 in paper copy, A01 in microfiche. Contribution No. 228, September 1982. 57 p., 17 Fig., 6 Tab, 22 Ref.

Descriptors: Groundwater, *Groundwater quality, *Municipal water quality, *Drought, Climate, *Climatic index, *Kansas, Saline waters, Evapotranspiration, Recharge, Infiltration, Rainfall, Water Supply, Aquifers.

Large variations in the chemical quality of municipal groundwater supplies in Kansas occur in response to dry and wet conditions. These changes are explained by varying amounts of recharge available to dilute mineralized groundwaters. The Palmer Drought Index and Eagleman Aridity Index are the best measures of climatic conditions controlling groundwater-quality variations in Kansas. Two aquifer areas of Kansas were found to contain most of the municipal well-water supplies exhibiting highly significant correlations between quality and climatic variability. In east-central Kansas, from th Nebraska to the Oklahoma state lines, groundwater is found in Permian limestones. Where these limestones contain gypsum, the hardness, sulfate, and dissolved solids concentrations increase during extended dry periods. In south-central Kansas, where groundwaters in sand and gravel aquifers may be underlain by Permian rocks containing saltwater, concentrations of sodium, chloride, and total dissolved solids increase in some well waters during drought. A couple of municipal water supplies from aquifers overlying or in Cretaceous rocks in central and north-central Kansas also show variations in either sulfate or chloride contents with dry or wet spells. Deterioration in water quality can be estimated for droughts of differing severity using linear or curvilinear relationships between water chemistry records and a climate index. These relationships can be used to predict possible variations in present and future well-water supplies in the aquifer areas generally subject to these water-quality changes.
W83-03044

WATER AND NITRATE-NITROGEN LOSSES FROM A SMALL UPLAND COASTAL PLAIN WATERSHED

Agricultural Research Service, Tifton, GA. Southeast Watershed Research Center, R.K. Hubbard and J.M. Sheridan.

Journal of Environmental Quality, Vol. 12, No. 2, p. 291-295, April-June, 1983. 4 Fig., 2 Tab, 13 Ref.

Descriptors: *Surface runoff, *Storm seepage, *Nitrates, Seasonal variation, Mathematical studies, Climate, Water pollution sources, Prediction, Small watersheds, Coastal plain.

Surface runoff (SRO) and shallow-subsurface flow (SSF) from a small, upland, Coastal Plain watershed underlain by plinthite were monitored for a 10-yr period. Samples collected during surface runoff and subsurface-flow events were analyzed for N03-N. The major water runoff loss from the system was found to be subsurface flow, accounting for 79% of total runoff loss, which occurred primarily from December through May. Nitrate-N concentrations in surface runoff and subsurface flow were relatively uniform over the period, averaging 0.47 and 8.75 mg/L, respectively. The combination of high volume of subsurface flow and its relatively high N03-N content, resulted in 99% of total NO3-N loss via subsurface flow. Predictive equations for monthly surface and subsurface water runoff losses from this watershed were developed using multiple linear regression. The equations contain seasonal and climatic parameters, including pan evaporation. Tests of the equations with observed results gave significant (P < or = 0.01) correlation coefficients, r, of 0.82 and 0.85 for surface and subsurface flows, respectively. Mean surface and subsurface N03-N concentrations were multiplied by predicted monthly flows to compute predicted monthly N03-N losses. Comparison of predicted and actual monthly N03-N losses gave significant (P < or = 0.01) correlation coefficients, r, of 0.59 and 0.86 for surface and subsurface flows, respectively. The good fit of predicted and observed results can be partially attributed to the seasonal and climatic data base collected over a relatively long period of 10 years. (Author's abstract)
W84-01188

A MARINE RECREATIONAL WATER QUALITY CRITERION CONSISTENT WITH INDICATOR CONCEPTS AND RISK ANALYSIS

V. J. Cabelli, A. P. Durom, L. J. McCabe, and M. A. Levin, Journal of the Water Pollution Control Federation, Vol. 55, No. 10, p. 1306-1314, October, 1983, 3 Fig., 4 Tab, 37 Ref.

Descriptors: *Recreation, *Indicator organisms, *Water quality, Risk analysis, Risks, Human diseases, Public health, Fecal coliforms, Coliforms, Microorganisms, Enterococcus, Swimming Marine environment.

The derivation of guidelines and standards based on acceptable risk for recreational water quality is explained. The two microbial guidelines or standards most commonly used in the U.S. are the total coliform limit of 1000/100 mL of water and the fecal coliform limit of 100/100 mL. The microbial guideline states that fecal coliforms should be used as the indicator organism for evaluating the microbiological suitability of frecreational waters. Coliforms were rejected as the indicator of choice for evaluating sanitary conditions because of their variable correlation with fecal contamination. Ideally, recreational water quality indicators are microorganisms or chemicals whose densities or concentrations in the water can be quantitatively related to swimming-associated health hazards. One problem with the existing microbial guidelines for direct contact recreational waters is that they are not amenable to, or developed in the context of risk analysis. They were derived from a barely detectable health effect rather than from exposure-response data. Therefore they do not allow for deliberate decisions by local, state, or federal officials about incremental decreases in the health risks involved. Rather, decision making is limited to acceptance or rejection of the specific limits. In a 3-year study of New York City beaches performed to determine which were the best indicators, the superiority of enterococci versus fecal coliforms was seen from the regression lines displayed on graphs of linear relationships between swimming-associated rates for gastrointestinal symptoms and mean enterococcus and fecal coliform densities in the water. Not only is this criterion more reliable because of the greater credibility of the information obtained, but also the consequences of the illness are more amenable to economic analysis. (Baker-IVI)
W84-02600

BACTERIAL INDICATORS OF RECREATIONAL WATER QUALITY

Health Effects Research Lab., Cincinnati, OH, A. P. Dufour.
Canadian Journal of Public Health, Vol. 75, No. 1, p. 49-56, January/February, 1984.

Descriptors: *Bacteria, *Bioindicators, Water quality, Recreation, Escherichia coli, Enterococci, Coliforms, Fecal coliforms, Human pathology, Gastroenteritis, Comparison studies.

The currently recommended bacterial indicator for measuring the quality of recreational waters in the United States is the fecal coliform group. Correlation analysis was performed on the swimming-associated gastroenteritis rates and the corresponding geometric mean densities of each indicator from multiple beaches and study units. The correlation coefficient was used as the measure of the "strength" of the relationship between each indicator of water quality and swimming-associated gastroenteritis. The results of the marine and freshwater studies indicate that one bacterial indicator (enterococci) meets most of the ideal characteristics. Most important is the fact that the density of this indicator correlated well with gastrointestinal disease associated with swimming. The regression line of swimming-associated gastrointestinal illness rates on enterococci density indicates that the illness rate approaches zero before the indicator density reaches one. E. coli density showed a strong relationship to health risk in freshwater, but not in seawater whereas fecal coliform density was not related to swimming-associated gastroenteritis in either aquatic environment. Although none of the indicators examined could fulfill all of the suggested characteristics, enterococci were able to meet more of them than E. coli or fecal coliforms. The epidemiologic method does not require establishing pathogen to indicator relationships since only illness incidence is measured. (Murphy-IVI)
W84-04012

BACTERIAL POLLUTION FROM AGRICULTURAL SOURCES: A REVIEW

Oregon State Univ., Corvallis, OR, Dept. of Agricultural Engineering, S. R. Crane, J. A. Moore, M. E. Grismer, and J. R. Miner.
Transactions of the American Society of Agricultural Engineers, Vol. 26, No. 3, p. 858-866, 872, May-June, 1983. 5 Tab, 82 Ref.

Descriptors: *Bacteria, *Agriculture, *Water pollution sources, *Livestock, Reviews, Animal wastes, Agricultural runoff, Vegetation, Surface waters, Bioindicators, Infiltration, Leaching.

The extent of bacterial contamination of surface and groundwaters associated with animal production units and waste application areas seems largely to depend on the production and waste management practices used by individual livestock operations. Management practices must be developed and proven both technologically and economically feasible which will reduce to a small percentage the indicator and pathogenic bacteria lost from these sites. Even with implementation of the best management practices, the indicator bacterial densities in runoff will probably range from 1000 to 100,000 organisms/100 mL as has been shown

previously to be the base or background level from agriculturally oriented land use areas. Specifics are offered concerning the determination of the quantity of bacteria transported from animal waste application sites, recommended practices to reduce health risks, management practices to minimize bacterial losses, application time and use of storage facilities, and site selection criteria for waste application sites and livestock operations. (Baker-IVI)
W84-04446

BACTERIAL QUALITY OF TILE DRAINAGE WATER FROM MANURED AND FERTILIZED CROPLAND

Department of Agriculture, Ottawa (Ontario), N. K. Patni, R. Toxopeus, A. D. Tennant, and F. R. Hore.
Water Research, Vol. 18, No. 2, p. 127-132, 1984. 6 Tab, 15 Ref.

Descriptors: *Drainage water, *Bacteria, *Tile drainage, *Manure, *Fertilizers, Coliforms, Streptococci, Water pollution sources, Groundwater pollution, Precipitation, Soil texture, Ontario.

Bacterial contamination of tile drainage water in three manured and one non-manured cropped fields was studied over a 4-year period at a large, mixed farm near Ottawa, Ontario, Canada. Concentrations of total coliforms, fecal coliforms (FC), fecal streptococci (FS) and Standard Plate Counts at 20 and 35 C, in both the drainage water and the applied dairy cattle liquid manure varied over a wide range. Bacterial concentrations in long-term winter-stored manure were much lower than in relatively fresh manure. Concentrations of FC and FS in the drainage water from the manured fields were lower than concentrations in the applied manure by 3-5 orders of magnitude. Bacterial concentrations in drainage water from all fields had low geometric mean and median values for all parameters tested. Water quality was satisfactory most of the time for recreational use or for use as a raw water source for drinking water supplies. Factors such as precipitation appeared to have a greater influence on drainage water quality than manure application. Influence of soil type on bacterial concentrations in drainage water from the manured fields was not evident. However, a lower unit-area tile outflow in coarse-textured soil compared to fine-textured soil indicated a greater potential in the former for fecal bacteria reaching groundwater beneath the tile drains. (Author's abstract)
W84-02743

BACTERIOLOGICAL AND VIROLOGICAL ANALYSIS OF WATER FROM FOUR FRESH WATER BEACHES

Institute Armand-Frappier, Laval (Quebec).
P. Payment, M. Lemieux, and M. Trudel.
Water Research, Vol. 16, No. 6, p. 939-943, June, 1982. 5 Fig., 2 Tab, 8 Ref.

Descriptors: *Bioindicators, *Pollutant identification, *Viruses, *Turbidity, *Separation techniques, *Sewage bacteria, Water analysis, Bacteria, Salmonella, Coliforms, Streptococcus, Enteric bacteria, Beaches, Lakes, Water pollution, Quebec, Deux-Montagnes Lake.

Water samples were collected from four public beaches located on Deux-Montagnes Lake during July and August of 1979 to evaluate the extent of viral pollution in recreational waters, to study the efficiency of two viral concentration methods, and to assess the adequacy of bacterial standards to monitor viral pollution. One twenty-liter water sample was taken from each of the four locations and analyzed for total coliforms, fecal coliforms, fecal streptococci, salmonellae, and enteric viruses. Viruses were effectively concentrated by filtration on a stack of 142 millimeter-size fiberglass filter discs, followed by a hydroextraction procedure. Statistical analysis of the data showed no correlation between the presence of viruses and enteric bacteria and no correlation between the presence of salmonellae and other bacterial indicators. When turbidity was greater than 10 nephelometric turbidity units, a positive correlation between virus isolation and water turbidity was apparent. Further studies are needed to see if correlations exist between viral concentrations in public bathing waters and disease incidence. (Geiger-FRC)
W83-02417

BEACH FECAL COLIFORMS

Gore and Storrie Ltd., Toronto (Ontario), M. D. Palmer and R. J. Dewey.
Canadian Journal of Civil Engineering, Vol. 11, No. 2, p. 217-224, June, 1984. 7 Fig., 3 Tab, 1 Append.

Descriptors: *Coliforms, *Beaches, *Ottawa River, *Ontario, Model studies, Water quality management, Rainfall-runoff relationships, Prediction, Cost analysis, Offshore momentum diffuser, Piers.

The urban beach on the Ottawa River at Britannia, in the city of Ottawa, has been closed periodically by health officials for fecal coliform levels in excess of 100 counts/100 mL. These events were generally related to rainfall events. A combination of the STORM runoff model and a two-dimensional dynamic lake type model successfully reproduced the fecal coliform levels of the beach. Elevated fecal coliform levels were associated with rainfall events and runoff from two large catchment upstream of the beach. Due to prevailing conditions in the lake, the second largest summer storm did not produce elevated fecal coliform levels while the third and fourth largest storms did. The models predicted these events. The STORM model was calibrated on a subcatchment and supplied the runoff flow volumes and pollution levels to the dynamic lake model. The other input data for the lake model were supplied by field measurements. The models were used to assess the effectiveness of management options to improve the water quality on the beach. Options studied include extension of the Britannia Pier, installing an offshore momentum diffuser, and removing the effects of one or two of the major upstream drainage basins. The cheapest option that ensure

acceptable beach water quality is the pier extension, but this option requires an affective die-off of fecal coliforms. The next best solution is the offshore momentum diffuser, which also requires a 60 m extension to the Britannia pier. (Moore-IVI)
W86-01711

COLIFORM ATTACHMENT TO SUSPENDED PARTICLES IN STORMWATER

Michigan Univ., Ann Arbor, School of Public Health, J. E. Schillinger and J. J. Gannon.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-108324, Price codes: A05 in paper copy, A01 in microfiche. Completion Report. January, 1982. 84 p., 16 Fig., 28 Tab, 131 Ref, 3 Append. OWRT A-111-MICH(1).

Descriptors: *Coliforms, *Suspended solids, *Stormwater, *Particulate matter, *Water quality, Bacteria, Microorganisms, Pathogens, Bacterial analysis, Water analysis, Sedimentation, Settling tanks, Filtration, Settling velocity, Storm runoff, Storm wastewater.

Fractional filtration and settling tests showed significant numbers of fecal coliforms (FC), Klebsiella sp. (KS) and Pseudomonas aeruginos (PA) (15-30% of cells), to be associated with stormwater suspended particles. Most of these were associated with the 30-52 and greater-than 52 micro fractions. The percentages of total filtered microorganisms retained on the 30 and 52 micro screens were for FC, KS, PA, and gram negative bacteria (GNB) were 80, 75, 68, and 87%, respectively. While large particles settled rapidly, sufficient numbers of single bacteria or aggregates less than 5 microns remain (above 50% of cells) to contribute to waterborne pollution, even after a 4-hour settling time. Significant differences were noted between adsorption of FC (16%) and pathogens KS and PA (26%), and between those groups and total GNB (37%) by retention on greater than 5 micro screens. Clay flocculation tests confirmed the lower adsorption/attachment rate of FC (E. coli used in lab tests), as observed in filtration and settling experiments; FC may not be ideal indictors of adsorption/settleability, but should be viewed as conservation indicators since other bacteria/pathogens may be more associated with suspended particles. (Zielinski-MAXIMA)
W83-00224

COMPARISON OF SEVERAL MICROBIOLOGICAL TOXICITY SCREENING TESTS

National Water Research Inst., Burlington (Ontario), B. J. Dutka, N. Nyholm, and J. Petersen.
Water Research, Vol. 17, No. 10, p. 1363-1368, 1983. 2 Fig., 5 Tab, 16 Ref.

Descriptors: *Toxicity, *Bioindicators, Microorganisms, Dichlorophenol, Cetyl trimethyl ammonium chloride, Sodium lauryl sulfate, Phenol, Copper sulfate, Mercury chloride, Zinc sulfate, Microtox system, Spirillum volutans, Sludge.

Four short-term microbiological toxicity screening tests were compared using the following test chemicals: 3.5 dichlorophenol, cetyl trimethyl ammonium chloride sodium lauryl sulfate, phenol, copper(II) sulfate, mercury(II) chloride and zinc(II) sulfate. These seven chemicals represent a wide range of toxicity. The methods examined were Beckman's Microtox system, the Spirillum volutans motility test, inhibition of respirator activity of activated sludge, and inhibition of activated sludge TTC-dehydrogenase activity. The results obtained indicate that each method has its own toxicity sensitivity pattern, and among the substances tested, only mercury(II) chloride and phenol were ranked equally by the four methods as the most and the least toxic chemical, respectively. In a tentative ranking of the methods, according to sensitivity, the Microtox test came out as the most sensitive test, followed by the Spirillum test, which in turn appeared more sensitive than the two sludge tests. This ranking has meaning only in a statistical sense, however, and the variable nature of the results support the philosophy that for assessing toxicity more thoroughly, a battery of several tests is required. (Author's abstract)
W84-02186

ENTEROCOCCI AND OTHER MICROBIAL INDICATORS IN MUNICIPAL WASTEWATER EFFLUENTS

Food and Drug Administration, Davisville, RI, Shellfish Sanitation Branch, J. J. Miescier and V. J. Cabelli. Journal of the Water Pollution Control Federation.
Vol. 54, No. 12, p. 1599-1606, December, 1982. 1 Fig., 8 Tab, 36 Ref.

Descriptors: *Indicators, *Bacteria, *Wastewater analysis, Pollutant identification, Monitoring, Sewage bacteria, Chlorination, *Wastewater treatment, Effluents, *Enterococci, Coliforms, Enteric Bacteria, Recreation, Swimming, Viruses.

Enterococci best satisfied the requirements for a microbial indicator in wastewater effluents. Samples collected from 9 municipal wastewater treatment plants in Rhode Island after primary, secondary, tertiary treatment, and chlorination were examined for densities of enterococci, Escherichia coli, fecal coliform, total coliform, Pseudomonas seruginosa, and Aeromonas Hydrophila. Densities of enterococci varied least from one plant to another and did not increase during primary of secondary treatment. This was not true of any other indicators tested. Mean enterococci densities (per 100 ml) were 190,000 after primary treatment; 11,000 after secondary treatment; and 1100 after tertiary treatment. Mean log 10 reductions in bacterial counts after chlorination were: fecal coliforms, 4.763; E. coli, 4.726; and enterococci, 3.573. These findings suggest that enterococci multiply little or not at all in transit to the plant and through the treatment process. They are more consistently related to the fecal wastes of the sewered population than the other organisms and may better simulate viruses with regard to chloride sensitivity. (Cassar-FRC)
W83-03551

ENTRAINMENT OF VIRUSES FROM SEPTIC TANK LEACH FIELDS THROUGH A SHALLOW, SANDY SOIL, AQUIFER

Brookhaven National Lab., Upton, NY, Dept. of Energy and Environment.

J. M. Vaughn, E. F. Landry, and M. Z. Thomas. Applied and Environmental Microbiology, Vol. 45, No. 5, p. 1474-1480, May, 1983. 1 Fig., 4 Tab, 25 Ref.

Descriptors: *Wastewater disposal, *Enteroviruses, *Entrainment, Viruses, Aquifers, Water pollution sources, Groundwater pollution, Water quality, Coliforms, Long Island, New York.

Movement of naturally occurring human enteroviruses from a subsurface wastewater disposal system through a shallow aquifer was studied on the south shore of eastern Long Island, New York. The potential for significant entrainment of virus particles was evidenced by their recovery at down-gradient distances of 67.05 m and from aquifer depths of 18 m. The specific limits of virus entrainment through the system could not be determined, as wells had not been installed beyond 67 m down-gradient of deeper than 18 m. A significant negative correlation was observed between virus occurrence and the distance from the "septage (leaching pool) source. Virus occurrence could not be statistically correlated with either total or fecal coliforms, indicating the limitations of current microbial water quality indicators for predicting virological quality of groundwater. (Moore-IVI)

W84-01651

EPIDEMIOLOGICAL ASSESSMENT OF WATER QUALITY AND "SWIMMERS EAR"

Yale Univ., New Haven, CT. Dept. of Epidemiology and Public Health, R. Calderon, and E. W. Mood.

Archives of Environmental Health, Vol. 37, No. 5, p. 300-305, September-October, 1982. 1 Fig., 5 Tab, 28 Ref.

Descriptors: *Water quality, *Bacteria, *Swimmer's ear, Otitis externa, Epidemiology, Public health, Swimming.

In an effort to determine if bacterial water quality was related to the incidence of otitis externa (swimmer's ear), a retrospective study was conducted from July 1980 to September 1980. Data from 29 cases and 29 controls matched for age and sex were collected. The disease appears to be primarily associated with people less than 18 years of age. Hot and humid ambient air appears to be associated with it. This association may be indirect rather than direct. Hot and humid air may determine the frequency and duration a person swims during periods of extreme weather. Swimming appears to be associated, but more important is the association with the quantity of time spent in the water swimming. Otitis externa does not appear to be associated with baceterial indicators of recreational water quality such as fecal coliforms, enterococci, or P, aeruginosa organisms. While P, aeruginosa may be the most commonly isolated organism from cases of otitis externa, the role of other bacterial etiological agents should not be excluded. (Baker-IVI)

W84-05283

FREQUENCY DISTRIBUTION OF COLIFORMS IN WATER DISTRIBUTION SYSTEMS

Drexel Univ., Philadelphia, PA, Dept. of Biological Sciences, R. R. Christian and W. O. Pipes.

Applied and Environmental Microbiology, Vol. 45, No. 2, p. 603-609, February, 1983. 1 Fig., 4 Tab, 15 Ref.

Descriptors: *Coliforms, *Drinking water, *Pennsylvania, *New Jersey, *Water distribution, Frequency distribution, Bacteria, Public health.

Nine small water distribution systems in Pennsylvania and New Jersey were sampled intensively to determine the patterns of dispersion of coliforms. Coliforms were not randomly dispersed in any of the water distribution systems. In all systems studied most locations yielded no coliforms. The frequency distributions of confirmed coliform counts were compatible with either the negative binomial or the lognormal distribution. They were not compatible with either the Poisson and Poisson-plus-added zeroes distribution. If the log normal model is representative of the coliform distribution, the arithmetic mean sample count is a poor estimator of the true mean coliform density. Also, the likelihood of a person consuming water with a very high coliform density is small but finite even if the system is now shown to be in violation. (Baker-IVI)

W85-00106

HALTING CREEK POLLUTION

Rogue Valley Council of Governments, Central Point, OR, E. Dittmer. Public Works, Vol. 113, No. 12, p, 39-40, December, 1982.

Descriptors: *Animal wastes, *Coliforms, *Parks, Recreation, Water pollution sources, Streams, Urban areas, Water treatment, Chlorination, Raccoons, Bacteria, *Oregon, Bear Creeks.

Even after elimination of a sanitary sewer leakage into a storm drain feeding into Bear Creek, Medford, Oregon, coliform counts remained in excess of federal standards, and thus posed risks for contact activity. Fecal bacterial pollution in this small urban park creek was traced to a three-member raccoon family living in a catch basin. Since all efforts to trap or exclude the animals failed, it was decided to treat the creek water by suspending 1 pound of swimming pool water purification tablets in the flow from a manhole upstream of the park. These tablets are renewed weekly on Thursday or Friday. Treatment is discontinued in winter. This treatment also controls pollution from pets which defecate in the park. (Cassar-FRC)

W83-02768

INADEQUACY OF DIVERSITY INDICES IN DISCERNING METAL MINE DRAINAGE EFFECTS ON A STREAM INVERTEBRATE COMMUNITY

Chadwick and Associates, Littleton, CO, J. W. Chadwick and S. P. Canton. Water, Air, and Soil Pollution, Vol. 22, No. 2, p. 217-223, 1984. 2 Fig., 1 Tab, 24 Ref.

Descriptors: *Diversity indices, *Metal mine drainage, *Invertebrates, Bioindicators, Measuring instruments, Mine drainage, Water pollution sources, Water pollution effects.

Diversity indices have long been used to assess impacts on stream invertebrate communities. By providing a single value, they allow rapid comparisons between stations without long species lists, density estimates, and other parameters that can confuse the non-biologist. The benthic invertebrates of the Dolores River in southwest Colorado were sampled during three seasons in an area of historic mine drainage. Benthic density exhibited significantly lower values below the mine drainage. However, the number of species did not decrease significantly, indicating that the effect of the mine drainage was primarily non-selective (i.e. favoring no one taxon). This pattern was seasonal with the least effects evident in summer and the greatest effects found in spring. Diversity indices used to assess the effects of this stress on the invertebrate community were Margalef's, Simpson's, Shannon-Weaver's, Brillouin's, and the Biotic Condition Index. None of the indices tested adequately responded to a decreasing trend in the benthic density when number of species remained constant. The indices did respond to a combination of low density and number of species. Diversity indices appear to be inadequate in assessing a non-selective stress. (Murphy-IVI)
W84-04212

MICROORGANISMS AS INDICATORS OF TOXICITY OF NATURAL AND WASTE WATERS

Gorkii State Univ. (USSR). Inst. of Chemistry, A. A. Tumanov, I. E. Postnov, N. I. Osipova, and I. A. Filimonova.
Hydrobiological Journal, Vol. 17, No. 5, p. 71-74, 1981, 26 Ref.

Descriptors: *Pollutant identification, *Bioindicators, *Biological magnification, Wastewater treatment, *Microorganisms, *Heavy metals, *Trace elements, *Water quality control Assay, Bioassay, Reviews, Indicators, Bacteria, Water analysis, Toxicity, Molds, Yeasts, Fungi, Monitoring, Trace metals.

The high sensitivity of microorganisms to metal ions, organic and organometallic compounds makes them useful indicators of small amounts of such pollutants in natural waters and wastewater. There is much controversy over whether more highly organized animals such as Daphnia are better indicators of pollution than the lower forms such as bacteria, Protozoa and algae. Some biotesting methods based on biochemical or physiological responses of microorganisms cannot always be used because of their complexity. The simplest biotests are often those based on changes in growth rates of microorganisms in a given chemical environment. Certain molds, yeasts and bacteria grow well on nutrient media and can be used as analytical indicators. The diffusion method may be used for determining the presence of phenol and petroleum products in wastewater with the aid of bacteria and yeasts. Automatic devices which continuously grow microorganisms are used for monitoring the toxicity of industrial effluents. Some bioactive agents can stimulate the growth of living organisms. The method of element determination which is based on stimulation effects can be used to detect the presence of trace elements in water. Biological concentration by organisms can be used as a process whereby rare and scattered elements could be extracted or as a method of purifying and analyzing wastewater. If solutions contain small amounts of toxic substances which cannot be directly detected, then chemical and biological methods of concentration need to be combined. In biological testing, other impurities in the water generally do not interfere with the analysis thus eliminating the need for sample preparation. (Geiger-FRC)
W83-01753

MODELING DAIRY WASTE MANAGEMENT SYSTEM INFLUENCE ON COLIFORM CONCENTRATION IN RUNOFF

Oregon State Univ., Corvallis, OR, Dept. of Agriculture Engineering, E. A. Moore, M. E. Grismer, S. R. Crane, and J. R. Miner.
Transactions of the American Society of Agricultural Engineers, Vol. 26, No. 4, p. 1194-1200, July-August, 1983. 1 Fig., 8 Tab, 55 Ref.

Descriptors: *Waste treatment, *Dairy industry, *Runoff, *Coliforms, Animal wastes, Waste management, Land application, Water pollution control, Watersheds, Bacteria.

A model is presented which is based upon a mass balance where the effects of significant factors on bacteria populations are quantified and summed for a specific time increment. These factors include number of cows in the herd, type, capacity and management of waste storage unit, bacterial die-off in storage, waste application method and rate, bacterial die-off on the surface, precipitation, infiltration of water and bacteria, and finally, transport. The information gathered from application of the model suggests the following facts for minimizing the bacterial pollution potential of land-applied dairy wastes. Storage will markedly decrease pollution of surface waters. Drainlines will reduce runoff volume and the transport of bacteria. Spreading wastes on well-draining soils in the winter helps to decrease pollution potential. Buffer zones are an effective waste management procedure in reducing the quantity of pollution entering streams. Heavy application rates

of wastes increase pollution potential. Runoff from barnyards laden with stacked animal wastes possesses the greatest pollution potential. (Baker-IVI)
W84-04461

OLIGOCHAETES AS INDICATORS OF POLLUTION IN THE HUMBER ESTUARY, WITH SPECIAL REFERENCE TO TUBIFICOIDES BENEDENI

Anglian Water Authority, Huntingdon (England). Lincolnshire River Div., B. E. Barnett.
Environmental Pollution, Series A, Vol. 30, No. 4, p. 277-291, 1983. 7 Fig., 1 Tab, 16 Ref.

Descriptors: *Water pollution effects, *Species diversity, *Oligochaetes, *Tubificids, *Bioindicators, *Distribution patterns, Industrial wastes, Coastal waters, Estuaries, Humber Estuary, *England.

Two intertidal surveys were conducted to examine the geographical and tidal distribution, abundance and numerical dominance of major oligochaete species in relation to the potential role of these organisms as indicators of pollution in the Humber Estuary, United Kingdom. Results showed that Tubifex costatus and Tubificoides benedeni were dominant species according to the Shannon-Weaver diversity index. Although data concerning oligochaete distribution and abundance must be interpreted with care, T benedeni appears to be a valid indicator of pollution in the Humber. Two sites receiving considerable volumes of industrial and domestic effluents coincide with extreme dominance areas for T benedeni and very low diversity values. T benedeni conducts its entire life cycle in the relative safety of the subsediment and exhibits a high tolerance for anoxia. These qualities make this tubificid oligochaete a genuine pollution indicator in the more same reaches of estuaries and coastal habitats. (Geiger-FRC)
W84-00025

POLLUTION INDICATORS AND POTENTIAL PATHOGENIC MICROORGANISMS IN ESTUARINE RECREATIONAL WATERS

Nova Scotia Research Foundation, Dartmouth, W. J. Robertson. Canadian Journal of Public Health, Vol. 75, No. 1, p. 19-24, January/February, 1984. 50 Ref.

Descriptors: *Bioindicators, *Pathogenic bacteria, *Estuaries, *Recreation, Water quality, Pathogens, Fecal coliform, Coliforms, Bacteria. Vibrio parahaemolyticus, Pseudomonas aeruginosa, Salmonella, Candida albicans, Canada.

The quality of marine recreational waters is now assessed using fecal coliforms, the recognized indicator of fecal contamination. It is assumed that the possibility of infections from water-borne pathogens increases as densities of fecal coliform increase. Fecal streptococci are also used as supplementary indicators. However, these indicators possess certain traits which limit their applicability. Within the last few years relatively easy techniques for enumerating the more common water-borne pathogens themselves have been developed, eg. Candida albicans. Pseudomonas aeruginosa, Salmonella and Vibrio spp. Studies are now underway to determine whether their densities correlate well with the presence of fecal indicators, in marine recreational waters. In estuaries the potential pathogen Vibrio parahaemolyticus appears to hold promise as a complementary indicator of the presence of sewage and other potential pathogens. (Author's abstract)
W84-04009

PROCESS BASED MODEL OF FAECAL BACTERIAL LEVELS IN UPLAND CATCHMENTS

Leeds Univ. (England). School of Geography, A. Jenkins, M. J. Kirkby, A. McDonald, P. Naden, and D. Day.
Water Science and Technology, Vol. 16, No. 5-7, p. 453-462, 1984. 3 Fig., 25 Ref.

Descriptors: *Fecal coliforms, *Process based models, *Model studies, Bacteria, Fate of pollutants, Catchment areas, Watershed management, Bacterial die-off, Washout, Sediment contamination.

A process based model of bacterial dynamics in a river is developed for use in the management of catchments where the waters are designated for potable supply. Fecal coliform bacteria was chosen for the model because it is an indicator in widespread use both in legislation and in practice and its significance is affirmed by the water industry. The argument for a process based model of bacterial stream dynamics is based largely on the concept of the watershed as a multiple storage and release system. The land surface store receivers direct fecal input by excretion from animals and from agricultural practices such as slurry spreading. The concentration of bacteria in water is increased by fecal input and washout from sediment and is reduced by settlement and die off. Numbers of bacteria in sediment are increased by settlement and reduced by die off and washout. Sample output is provided to demonstrate that the model is capable of simulating some of the bacterial conditions for which data exist. The model could help to identify the amount of flushing required to reduce channel bacterial levels to within given standards. (Moore-IVI)
W85-01420

ROUTINE COLIFORM MONITORING AND WATERHORSE DISEASE OUTBREAKS

Columbia Univ., New York. School of Medicine. O. Batik, G. F. Craun, and W. O. Pipes.
Journal of Environmental Health, Vol. 45, No. 5, p. 227-230, March-April, 1983. 3 Tab, 6 Ref.

Descriptors: *Coliforms, *Drinking water, *Waterborne disease, Bacteria, Water quality standards, Water quality, Human diseases.A comparison of coliform monitoring results was made between water systems experiencing a

waterborne outbreak and systems in which an outbreak had not been reported. In a study of community systems, the outbreak and comparison communities were not found to differ in regard to positive coliform results within the three months prior to the outbreak. Also, no statistical difference was observed between outbreak and comparison communities with respect to the number of times the coliform standard was exceeded per number of samples collected and mean number of coliform organisms in the water system during an entire three year period. A study of coliform monitoring results for non-community systems in Pennsylvania show no difference in positive coliform results between non-community systems experiencing an outbreak and those not experiencing one. These data provide no evidence that coliform monitoring provides any prediction of outbreaks of waterborne disease in non-community systems. These results must be interpreted cautiously for several reasons, including small sample size and incomplete reporting of waterborne outbreaks. It is suggested that regulatory agencies should carefully examine the relative importance of the routine coliform monitoring of tap waste in the surveillance of waterborne disease. (McKeon-IVI)
W84-01204

SELECTION OF PRACTICAL INDICATOR SYSTEMS FOR MONITORING THE VIROLOGICAL QUALITY OF POTABLE WATER, WASTEWATER, SOLID WASTE, SHELLFISH, FISH AND CROPS

Cincinnati Univ., OH. Dept. of Civil and Environmental Engineering, P. V. Scarpino.
Water Science and Technology, Vol. 15, No. 5, p. 17-32, 1983. 5 Tab, 69 Ref.

Descriptors: *Viruses, *Bioindicators, *Water analysis, *Wastewater analysis, Potable water, Indicators, Monitoring, Bacteria.

The actual detection of viruses of the use of an indicator system or systems to assess the presence of pathogenic viruses in contaminated environments is essential for the protection of human health. An ideal microbial indicator for assessment of viral presence should include the following properties: applicability in all types of environments, present whenever viral pathogens are present, have a reasonably longer survival time than the hardiest enteric viral pathogen, should not reproduce in the contaminated environment, and should be harmless. The possible surrogate relationships between pathogenic viruses and bacterial indicators of fecal pollution in the diverse environments of potable water, wastewater, solid waste, shellfish, fish and crops are considered. Assessments are made concerning the reliability of the indicator to identify in these diverse environment viral presence. Thus far no one has demonstrated a convincing relationship between the numbers and/or types of different indicator bacteria and the pathogenic viruses themselves. The search should continue for more acceptable alternatives which would eliminate the need for the more difficult and time consuming direct testing of pathogenic virus presence, the best indicator for pathogenic virus presence may be the virus itself. (Moore-IVI)
W84-02256

THERMOTOLERANT NON-FECAL SOURCE KLEBSIELLA PNEUMONIAE: VALIDITY OF THE FECAL COLIFORM TEST IN RECREATION WATERS

N. R. Caplenas and M. S. Kanarek, American Journal of Public Health, Vol. 74, p. 1273-1275, 1984. 1 Tab, 10 Ref. EPA contract C3043NAEX.

Descriptors: *Klebsiella, *Fecal bacterial, *Coliforms, *Wisconsin, *Pulp wastes, Pulp and paper industry, Water quality standards, Industrial wastewater, Effluents, Bacteria, Water reuse.

Thermotolerant Klebsiella bacteria from an industrial wastewater source of non-fecal origin consistently elevate the level of fecal coliform organisms as measured by the current fecal coliform standard test. Water samples were obtained from pulp and paper mills in Wisconsin. The sampling points examined for bacterial densities included fresh water supplies, recycled water within mills treated effluent wastewater. and waters receiving effluent wastes downstream from nine pulp and paper mills. Using the standard fecal coliform test, up to 90% of non-fecal source thermotolerant K pneumoniae was falsely identified as fecal source bacteria. Isolating Klebsiella from a variety of mill types and processing stages, indicates the ubiquity of Klebsiella in the pulp and paper mill industry. The use of water recycle systems promotes enhanced thermotolerant bacterial concentrations by providing an excellent growth environment for Klebsiella. Since there is a lack of specificity in the currently used standard for fecal coliform evaluation, a more reliable health risk assessment for fecal coliform bacteria is recommended. A highly specific indicator of fecal waste contamination, themotolerant fecal coliforms as measured by Escherichia coli, should be used as the standard fecal coliform guideline. (Moore-IVI)
W85-03747

VIRUSES IN SOIL AND GROUNDWATER

Vaughn, J. M.; Landry, E. F. (Brookhaven National Lab., Upton NY (USA)). 1981. Contract AC02-76CH00016. 136 p. NTIS, PC A07/MF A01. Order Number DE84001267.

Human viruses usually gain access to soil systems through intentional or unintentional discharges of domestic wastewater. Intentional land treatment/disposal systems represent an attractive alternative to surface water discharges, providing both economic and environmental advantages. Major concerns over the possible threat to human health as a result of the large-scale use of such systems are as yet unresolved. One such concern involves the potential for viral contamination of groundwater systems which currently supply the drinking-water needs of half the United States population. While no groundwater-borne disease outbreaks of viral etiology have as yet been associated with land treatment use, the potential for their occurrence has been clearly indicated by epidemiological studies of outbreaks associated with groundwater pollution from unintentional modes of soil application. Epidemiological evidence has been supported by an increasing number of field studies which have demonstrated viral contamination of shallow aquifers resulting from the use of various land treatment modes, such as rapid infiltration/recharge systems. More recent studies have indicated that soil-associated microbial pollution of groundwater may be abated by the use of systems management practices based upon an understanding of the physical and chemical factors which influence viral retention in soil including: temperature; pH; moisture, clay and ion content; depth to groundwater; infiltration rate; and soil continuity. The proper manipulation of these principles in the operation of land treatment schemes which utilize high-quality wastewater effluents should provide the means for significantly diminishing the likelihood of viral movement to groundwater systems.

A CASE STUDY OF DRY WELL RECHARGE

Arizona Water Resources Research Center, Tucson, AZ, L. G. Wilson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-110865, Price codes: A04 in paper copy, A01 in microfiche. Completion Report, September 1983. 55 p., 15 Fig., 13 Tab, 10 Ref. OWRT A-114-ARIZ(1), 14-34-00001-1103

Descriptors: *Urban runoff, *Waste disposal wells, Water pollution, Vadose water, *Recharge wells, Storm runoff, *Arizona, Tucson.

Five injection tests were conducted on an experimental dry well at a site near Tucson, Arizona. Goals of the tests were to determine (1) intake characteristics of the well, (2) flow patterns in the vadose zone, and (3) attenuation of urban runoff pollutant analogs (metals, microorganisms, and organic matter) in vadose zone/ground-water flow systems. Specific intake rates exceeded specific capacity values at a nearby pumping well. A perched groundwater system and a water table mound were observed by neutron moisture logging with lateral flow velocities averaging 500 ft/day. Metals were detected breaking through in a vadose-zone sampling well. Microbial tracers also arrived at the vadose zone sampling well, but peak values were markedly reduced below input values. The initial concentration of organic matter breaking through in the sampling well was 58% of the input values. No organic matter or microorganisms were detected in pumped ground-water samples. It was generally concluded that (1) dry well injection of urban runoff may develop perched ground water systems capable of spreading infected water within the radius of influence of nearby wells, and (2) given the pollutant loading rates of the test groundwater was not deteriorated in quality.
W84-00013

A LABORATORY/FIELD INVESTIGATION INTO THE BIOLOGICAL EFFECTS OF URBAN RUNOFF

Massachusetts Univ., Amherst, MA, Water Resources Research Center. C. Medeiros and R. A. Coler.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-177956, Price codes: A05 in paper copy, A01 in microfiche. Publication No 130, July 1982. 65 p., 20 Tab, 11 Fig., 69 Ref. OWRT A-126-MASS(1), 14-34-0001-9023.

Descriptors: *Urban runoff, *Fish toxins, *Toxicity, Water quality Macroin vertebrates, *Heavy metals, Fathered minnows, Brook trout, Black Nose Dove, *Massachusetts, Greenfield, Green River, *Lethal limit.

The effects of urban runoff on the hatchability, survival and growth of Pimephales promelas was assessed in the laboratory using flow-through (proportional diluter) and static (38.1 aquaria) systems. In the field, urban runoff was assessed using artificial substrates/live traps to derive diversity, survival, and metal accumulation values. To correlate toxicity with water quality, chemical analysis were performed on water, suspended solids, and sediments at 2 river stations and 2 runoff input sources. Results showed a large variability in runoff chemistry between seasons and even within the same storm. The long term toxicity test with the fathead minnow showed growth to be limited to 50% of control values at approximately 60% of full strength. The maximum allowable toxicant concentration (MATC), on the other hand was approximately 28%. Hatchability and average length as indicators of stress, were not as sensitive as millimeters produced per treatment and maximum and minimum sizes. The field studies largely confirmed the laboratory chronic studies. Significant differences in survival, diversity, and heavy metal accumulation did not occur until snow melting or rain events occurred. During such periods, diversity values approached one half those of the controls, and heavy metal content was 2 to 10 times control levels.
W83-02210

ACCUMULATION OF SELECTED TRACE METALS IN SOILS OF URBAN RUNOFF DETENTION BASINS

Oklahoma State Univ., Stillwater, Dept. of Forestry. P. J. Wigington, Jr., C. W. Randall, and T. J. Grizzard.
Water Resources Bulletin, Vol. 19, No. 5, p. 709-718, October, 1983. 8 Fig., 5 Tab, 19 Ref.

Descriptors: *Trace metals, *Detention reservoirs, *Storm runoff, *Soil contamination, Urban runoff, Cadmium, Copper, Lead, Zinc, Washington, District of Columbia.

Field investigations were conducted at three sites in the Washington, D.C., area to detect accumulation patterns of the trace metals, cadmium, copper, lead, and zinc in the soils of urban stormwater detention basins. The research results seemed to indicate that the use of detention basins to control urban stormwater runoff had few harmful effects to fine textured soils with respect to the study trace metals. Although the trace metals, especially lead and zinc, were found to accumulate in the surface soils of the basins, little significant downward movement of metals in the soil profiles had occurred. Accumulations of metals in the surface soils appeared to be a function of microtopography and the resultant resident time of standing water. The fractions of trace metals that were present in a leachable form in surface soils and stormwater solids were small, with median values ranging from 7.7% of the total concentration for Cd to 0.01% for Pb. (Author's abstract)
W4-02158

CHARACTERISTICS OF LEACHATES FROM HAZARDOUS WASTE LANDFILLS

Ghassemi, M.; Quinlivan, S. (Multidisciplinary Energy and Environmental Systems and Applications (MEESA). San Pedro, CA). *Journal of Environmental Science and Health, Part A: Environmental Science and Engineering*; A19: No. 5, 579-620 (1984).

A hazardous waste landfill leachate data base covering some thirty leachates from eleven disposal sites has been developed. The sites cover a range of sizes, liner designs, waste types and leachate collection systems and the leachate data cover a range of organic and inorganic constituents. For the cases included, the inorganic constituents appearing in highest concentrations in the leachate are iron, calcium, magnesium, cadmium, and arsenic, and the organic constituents appearing in highest concentrations are acetic acid, methylene chloride, butyric acid, 1,1-dichloroethane, and trichlorofluoromethane. The constituent concentrations in the leachate from hazardous waste landfills fall within the reported ranges for municipal landfill leachate. Based on preliminary data, only gross correlations could be made between leachate quality and waste input.

CHARACTERIZATION OF NON-POINT WASTE SOURCES, REPORT NO. 6: SUMMARY OF NON-POINT WASTE LOADS, (FOX RIVER VALLEY, WISC.)

McMahon Associates, Inc., Menasha, WI. R. R. Much and G. Kemp.
Report, April 1978. 135 p., 13 Fig., 30 Tab, 4 Append.

Descriptors: *Water pollution sources, *Waste load, *Watersheds, *Sediment discharge, *Septic tanks, Septic wastewater, Dredging, Water quality, Storm runoff, Storm seepage, Surface water, Pollutants, Heavy metals, Chemical wastes, *Wisconsin, Fox River Valley.

As part of the planning program for Wisconsin's Fox Valley 208 area, the Fox Valley Water Quality Planning Agency conducted 5 non-point waste source characterization studies to analyze the most significant non-point waste sources in the Fox Valley, to determine if they are significant to water quality, and to determine what actions need to be taken for more precise characterizations. Non-point sources of water pollution are defined as: urban and rural storm water runoff; subsurface flows discharging into surface water; multiple, small scattered sources such as residential septic tank systems or activities, for example, dredging and construction of facilities that involved some disruption of the land or water environment and thereby introduce pollutants into the water system. This report summarizes the key finding of each of the 5 studies and identifies topics requiring additional study and the type of program required to accomplish the work. The total Characterization of Non-Point Waste Sources Program used a literature review and study area inventory and survey, a sampling and monitoring program to obtain primary data, and a determination of pollutant loadings and associated conditions. The five studies conducted were: 1) test watershed monitoring and sampling program; 2) sediment source and delivery rate study; 3) survey of toxic chemicals use and distribution; 4) septic tank study; and 5) instream alteration study. (Fazio-Omniplan)
W85-00833

COMPARISON OF BASIN PERFORMANCE MODELING TECHNIQUES

Espey, Huston and Associates, Inc., Austin, TX. Environmental Engineering Div. G. F. Goforth, J. P. Heaney, and W. C. Huber.
Journal of Environmental Engineering, Vol. 109, No. 5, p. 1082-1098, October, 1983. 10 Fig., 6 Tab, 10 Ref.

Descriptors: *Comparison studies, *Basins, *Performance evaluation, *Model testing, Water pollution control, Storm water, Water management, Runoff volume, Stormwater detention basins, Drawdown, Drainage area.

Combined separate storm sewer overflows contribute similar magnitudes of contaminant loads to receiving waters as does secondary treatment effluent. A comparison of methods used for analyzing the long-term pollutant removal efficiency in a stormwater detention basin points out some fundamental differences between simulation, using EPA's Storm Water Management Model, and a statistical technique advanced by Hydroscience, Inc. For the 24.6-yr record of Atlanta, Georgia hourly rainfall, the mean runoff event volume predicted by each method is similar. However, the inability of the statistical method to account for the reduction in the number of events (due to indigenous catchment storage) results in an estimate of total runoff 30% greater than the simulation results. The statistical technique employees a pollutant removal expression applied to the total flow captured in the detention basin, as contrasted to the simulation utilization of intra-event pollutant kinetics for removal within the basin. Solution surfaces of runoff flow capture and pollutant removal efficiencies are developed for each method as a function of basin volume and drawdown rate. The differences in performance estimates between the two methods increase as the basin volume and drawdown rate increase, with the statistical technique yielding the lower estimate of flow capture. For a long-term pollutant removal efficiency of 70%, the annual cost associated with a basin designed by the statistical technique is approximately twice that of a basin designed by simulation. The program SYNOP generates rainfall event statistics which may be incorporated with simulation, providing a coordinated approach for analyzing the performance of stormwater detention basins. (Murphy-IVI)
W84-03088

CONCENTRATIONS OF ORGANIC PHOSPHATE NITROGEN, AND CARBON IN STORM RUNOFF AND COMBINED SEWERS IN THE GREATER WASHINGTON, D.C. AREA

American Univ., Washington, D.C. Dept. of Biology, M. A. Champ.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-105576, Price codes: A04 in paper copy, A01 in microfiche, Water Resources Research Center Report No. 54, Univ. of the District of Columbia, Washington, D.C., September 1983. 49 p., 6 Fig., 7 Tab, 34 Ref, 1 Append. OWRT A-004-DC(1), 14-31-001-50502.

Descriptors: *Organic phosphate, *Nitrogen, *Dissolved organic carbon, Combined sewer, *Street runoff samples, Shopping center parking lot, Rock Creek, Potomac River, Nutrients, River estuary, *District of Columbia, *Storm sewer runoff.

Concentrations of organic phosphate, nitrogen, and carbon have been determined in storm and combined sewers, sanitary sewers, street runoff, shopping center parking lot runoff, residential and industrial areas, and Rock Creek to determine their range of variation and relative magnitude. Combined sewers exhibit tremendous variation in organic carbon, and nitrogen concentrations. Estimates of the nutrient loads by major sources (storm sewers, combined sewer over flows, etc.) to the upper Potomac River Estuary for 1977 indicate that during a low flow year, combined sewer overflow contributes an insignificant amount of phosphate, nitrogen and carbon. However, during the same period the storm sewer runoff did contribute high loads of carbon and was a minor source of nitrogen.
W83-04159

EFFECTS OF VARIOUS HYDROLOGIC PARAMETERS ON THE QUALITY OF STORMWATER RUNOFF FROM A WEST LAFAYETTE, INDIANA URBAN WATERSHED

Purdue Univ., Lafayette, IN. Dept. of Environmental Engineering. M. S. Blumberg and J. M. Bell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-207380, Price codes: A07 in paper copy, A01 in microfiche, Water Resources Research Center Technical Report No. 162, January 1984. 121 p., 26 Fig., 19 Tab, 44 Ref, 2 Append. Project No. OWRT C-00090-U-IND(2), Contract/Grant No. 14-34-0001-0498.

Descriptors: *Wastewater effluents, Wastewater treatment, *Stormwater runoff, Water quality, Regression analysis, *Indiana, *Urban watershed, West Lafayette.

Increasingly stringent quality standards for wastewater effluents, and increased efficiency of wastewater treatment plant operations, have made the pollution due to stormwater runoff more obvious. This study investigated the quality of stormwater runoff from a 29 acre, fully developed, residential watershed. The important of various hydrologic activities (average intensity of rainfall, peak intensity of rainfall, total rainfall, peak rate of runoff, total runoff, and duration of precipitation event) on stormwater pollutant concentrations, total mass (or number), and peak rates was evaluated by multiple regression analyses. One has 99% confidence in the regression models developed for total mass (or number) and peak rate of all pollutants studied, and 97% confidence in the models developed for average and peak concentrations of total coliforms. The hydrologic activities accounted for 33-87% of the variance in the pollutant data. Several postulated relationships were examined using data collected during this study. No relationship was apparent between the quantity of previous rainfall or the length of the antecedent dry period and the quality of stormwater runoff. Neither was an overall trend apparent between the time elapsed since street cleaning and the quality of stormwater runoff.
W85-01822

EFFECTIVE IMPERVIOUS AREA IN URBAN RUNOFF MODELING

Geological Survey, Reston, Va. W. M. Alley and J. E. Veenhuis.
Journal of Hydraulic Engineering, Vol. 109, No. 2, p. 313-319, February, 1983, 2 Tab, 11 Ref.

Descriptors: *Urban runoff, *Model studies, *Impervious areas, Runoff, Denver, Colorado, Metropolitan water management, Urban areas.

Methods of estimating impervious areas are described and some effective impervious area data is summarized. The ramifications of effective impervious area concepts in urban runoff modeling are analyzed. Results from many urban runoff models are sensitive to the value used for impervious area. Large differences in results can be obtained depending on whether total impevious area (TIA) or effective impervious area (EIA) calculates are used. TIA may be appropriate for black-box models but not for deterministic ones. Potential problems of using TIA in the more deterministic models include: runoff volumes and peak flows may be largely overestimated for ungaged watersheds; simulated changes in runoff, on a percentage basis, due to increasing intensity of land use may be smaller if TIA is used rather than EIA; and over estimates of the infiltration rates are likely if the model is calibrated using TIA and measured rainfall-runoff data. Impervious area data collected from 19 urban watersheds in the Denver metropolitan area suggest a large potential exists for developing relationships between EIA and TIA for an urban area, either through a regression equation between the two variables or through estimates of the ratio EIA-TIA as a function of land use. (Baker-IVI)
W84-04834

EFFECTS OF URBANIZATION OF FREQUENCIES OF OVERFLOWS AND POLLUTANT LOADINGS FROM STORM SEWER OVERFLOWS: A DERIVED DISTRIBUTION APPROACH

Virginia Polytechnic Inst. and State Univ., Blacksburg, UA, Dept. of Civil Engineering, G. V. Loganathan and J. W. Delleur.
Water Resources Research, Vol. 20, No. 7, p. 857-865, July, 1984. 7 Fig., 4 Tab, 23 Ref, 1 Append. OWRT project OWRT-A-057 IND.

Descriptors: *Urban runoff, *Storm wastewater, *Water pollution sources, Storm sewer overflows, Storm runoff, River flow, Analytical models, Distribution, Urbanization, Biochemical oxygen demand.

On the basis of exponential density functions for volume of runoff, interevent time, and duration of runoff event and beta density for the rescaled pollutant (biochemical oxygen demand) concentrations and gamma density for river flow volumes during a critical period, new distributions are derived for overflow volumes and for quality of pollutant in the river after mixing with the untreated overflows of the overtaxed system. This is accomplished by means of hydrological relationships between different variables. The current data on runoff volume, duration of runoff events, etc., are transformed to account for future urbanization activities. The newly formed variables are used in the derivation of probability distributions for over flows and receiving body pollutant concentration after urbanization. The analytical model is compared with the simulation model "STORM." (Author's abstract)
W85-02152

EFFECTS OF URBANIZATION ON PHYSICAL HABITAT FOR TROUT IN STREAMS

Montana State Univ., Bozeman, MT, Dept. of Biology. R. J. White, J. D. Wells, and M. E. Peterson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB84 190131, Price codes: A03 in paper copy, A01 in microfiche. Montana Water Resources Research Report No. 139, Bozeman, October 1983. 48 p., 8 Tab, 6 Fig., 18 Ref, 1 Append. OWRT Project No. A-134-MONT(1), Contract/Grant No. 14-34-001-2128.

Descriptors: *Trout, *Stream, Fisheries, Habitat, *Channel improvement, Fish populations, Bank stablization, Shoreline cover, Fish management, *Montana, Urban streams, Nonurban stream, Wyoming Habitat Quality Index.

Non-urban were more favorable than urban stream sections as habitat for trout and held more trout. The major habitat difference was the amount of instream solid overhead hiding cover. Urban land modifications had created unnaturally straight, narrow channels with high, unstable banks with little of the undercuts and woody debris that provide shelter for fish. Urban and non-urban sections did not differ significantly with respect to water velocity, dissolved nitrate, or amount of pools or water turbulence. Pet unit stream length, non-urban sections averaged 54% more trout larger than 20 cm (8 inches) and 74% greater total trout biomass than urban sections. In both urban and non-urban areas, trout abundance as kg/ha was generally below the level predicted by the Wyoming Habitat Quality Index (HQI). This could have been due to effects of angling or other unmeasured factors, to measurement errors or to inapplicability of the HQI method to the areas studied. There is evidence that altering the HQI method to consider solid overhead hiding cover and pool-turbulence hiding cover as separate variables rather than as a total cover index will enhance predictiveness. Implications for urban stream fishery management are discussed.
W85-00070

EFFECTS OF URBANIZATION ON PHYSICAL HABITAT FOR TROUT IN STREAMS

White, R. J.; Wells, J. D.; Peterson, M. E. (Montana State Univ., Bozeman, MT, (USA). Water Resources Research Center). Oct 1983. 50p., NTIS, PC A03/MF A01.

Prepared in cooperation with Montana State Univ., Bozeman and Montana Dept. of Fish, Wildlife and Parks, Bozeman.

Non-urban were more favorable than urban stream sections as habitat for trout and held more trout. The major habitat difference was amount of instream solid overhead hiding cover. Urban land modifications had created unnaturally straight, narrow channels with high, unstable banks with little of the undercuts and woody debris that provide shelter for fish. Urban and non-urban sections did not differ significantly with respect to water velocity, dissolved, nitrate, or amount of pools or water turbulence. Per unit stream length, non-urban sections averaged 54% more trout larger than 20 (8 inches) and 74% greater total trout biomass than urban sections. In both urban and non-urban areas, trout abundance as kg/ha was generally below the level predicted by the Wyoming Habitat Quality Index (HQI). This could have been due to effects of angling or other unmeasured factors, to measurement errors or to inapplicability of the HQI method to the areas studied. There is evidence that altering the HQI method to consider solid overhead hiding cover and pool-turbulence hiding cover as separate variables rather than as a total cover index will enhance predictiveness.

EROSION OF BANKS ALONG PIEDMONT URBAN STREAMS

North Carolina Univ. at Charlotte, NC, Dept. of Geography and Earth Sciences. M. P. Wilson.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-206292, Price codes: A03 in paper copy, A01 in microfiche, Water Resources Research Institute Report No. 189, North Carolina State

Univ., Raleigh, February 1983, 38 p., 14 Fig., 1 Tab, 23 Ref. OWRT A-113-NC(1), 14-34-0001-0135.

Descriptors: *Stream erosion, *Erosion, *Bank erosion, *Stream banks, Banks, Urban drainage, Slope degradation, Urban areas, North Carolina, Piedmont streams.

Urbanized and non-urbanized tributary streams of the Piedmont are usually cut into post-European reddish sands and pre-European-settlement gray cohesive soils. These streams are eroding by scour and bank failure. Currently, berms (or inner-channel terraces) are a common product of bank failure; otherwise inner-channel deposition is rare and consists of point bars formed as meanders begin to develop. The cohesive sediments are more scour resistant than the sandy sediments. Bank failure is of the slab type, and is a normal part of the erosion process. Traditional design approaches have failed to create stable channels, primarily because (1) we do not understand erosive processes in cohesive sediment, and (2) urban environments require abnormally narrow channels. Erosion in channels less than about twelve feet deep can be reduced significantly by consideration of natural fluvial processes, artificial berm development, and judicious use of rip-rap. Torvane strength, color, composition and particle size distribution readily characterize bank materials and their erodibility.
W83-02945

ESSENTIAL URBAN DETENTION PONDING CONSIDERATIONS

Wright Water Engineers, Inc., Denver, CO. J. E. Jones and D. E. Jones, Jr.
Journal of Water Resources Planning and Management, Vol. 110, No. 4, p. 418-433, October, 1984. 8 Ref.

Descriptors: *Detention reservoirs, *Urban runoff, *Runoff management, Storm runoff, Planning, Community development.

Widespread misapplication of detention ponding is probably attributable to the simplicity and attractiveness of its basic concept, combined the lack of awareness or appreciation of complex interrelationships which influence its performance in urban drainage systems. There is urgent need to properly relate runoff management and flood plain management to total urban water resource management. Some fundamental and peripheral consideration that often bear upon proper integration of detention ponding into urban water resource management are reviewed. The most frequently encountered problem with detention ponding is the way it has been implemented out of context, by itself, as a mechanism for reducing peak runoffs from individual development sites. Communities should develop detention ponding programs only if they have the desire to manage creatively and effectively their stormwater problems and improve the living environment for the public. The level of community commitment required and the importance of multipurpose facilities are often underestimated. A wide variety of operational, maintenance, attitudinal and institutional questions should be individually addressed during planned and design decision making. (Moore-IVI)
W85-03062

ESTIMATING RUNOFF VOLUMES FROM URBAN AREAS

Chalmers Univ. of Technology, Goeteborg, (Sweden). Institutionen foer Vattenbyganad, V. Arnell.
Water Resources Bulletin, Vol. 18, No 3, p. 383-387, June, 1982. 4 Fig., 2 Tab, 12 Ref.

Descriptors: *Runoff volume, *Rainfall-runoff relationships, *Urban drainage, *Mathematical models, Mathematical studies, Mathematical equations, Urban areas, Regression analysis, Catchment areas, Model studies, Rainfall.

An equation for estimating runoff volumes from urban areas was formulated based on the part of a total area contributing to runoff, the rainfall amount for a single event, and the initial rainfall losses. For the evaluation of the part of a total area contributing to runoff and the initial rainfall losses, rainfall/runoff measurements were taken in five residential catchment areas ranging in size from 0.035 sq km to 1.450 sq km. Initial rainfall losses were found to vary from 0.38 mm to 0.70 mm for the different test sites according to linear regression analysis of rainfall volumes versus runoff volumes. The parts of the areas contributing to runoff were proportional to the impermeable parts of the areas. The present equation may be applied to the estimation of runoff volume in urban sections with well defined paved surfaces and roofs and with a negligible amount of runoff from permeable areas. (Geiger-FRC)
W83-00007

ESTIMATING URBAN TIME OF CONCENTRATION

Maryland Univ., College Park, MD, Dept. of Civil Engineering. R. H. McCuen, S. L. Wong, and W. J. Rawls,
Journal of Hydraulic Engineering, Vol. 110, No. 7, p. 887-904, July, 1984. 2 Fig., 6 Tab, 23 Ref, 1 Append.

Discriptors: *Concentration time, *Flood flow, *Urban watersheds, Mathematical equations, Flood peak, Flood hydrographs, Rainfall intensity.

Hydrologic flood-flow design methods generally require one time parameters, such as the time of concentration, as input, and the accuracy of the estimated peak discharge or flood hydrograph is sensitive to the accuracy of the estimated time parameters. Numerous equations for estimating the time of concentration have been proposed. Eleven equations for estimating t sub c are compared using data collected from 48 urban watersheds located in most regions of the country. All the watersheds had areas less than 4,000 acres; the average impervious was 29.1%, and the mean time of concentration was 1.49 hr. Using accuracy

and bias as the criteria for comparison, the eleven equations show wide variation in accuracy and bias. Two equations are calibrated with the data; the rainfall intensity is found to be the most important input parameter. The mean time of concentration computed by the velocity method for the 48 watersheds agrees very closely with the mean time computed from rainfall and hydrograph data. However, for individual watersheds the differences are relatively large. (Author's abstract)
W85-01557

EXECUTIVE SUMMARY, WATER POLLUTION STUDIES, FOX RIVER VALLEY, WISCONSIN

Killam (Elston T.) Associates, Inc., Millburn, NJ. Report, May 1978. 47 p., 5 Fig., 8 Tab, 1 Append.

Descriptors: *Water pollution sources, *Agricultural watersheds, *Urban watershed, *Sediment discharge, *Toxicity, *Septic tanks, *Dredging, *Trophic level, *Nutrients, Water quality, Chemical wastes, Pesticide toxicity, Heavy metals, Eutrophication, Chlorophyll a, Phosphorus, Pollutants, Wastewater treatment, Water pollution control, Lakes, Bays, Rivers, *Wisconsin, *Fox River Valley.

During 1976, consultants to the Fox Valley Water Quality Planning Agency identified existing and projected magnitudes of non-point source pollution in the Fox River Vally Waters. These studies were necessary to complete the Agency's Areawide Waste Treatment Management Planning responsibilities. The Agency also sponsored studies of the trophic status of the Winnebago Pool and Lower Green Bay to set a benchmark for measurement of future pollution control, and it developed a nutrient budget for the pool lake system for decision-making about water quality goals. The six-volume Characterization of Non-point Waste Sources contains the findings, the methodology, and raw concentration and flow data. Two different trophic assessment methods found Winnebago Lake to be the most eutorphic of 12 Wisconsin lakes but without excessively high levels of chlorophyll-a in comparison to other shallow lakes around the world. In the Inner Bay area, loading of phosphorus from the Lower Fox River accounts for approximately half of the variability of average total phosphorus concentration. The nutrient budget, technically linking the non-point source and tropic status studies, contains six sources of nutrient pollution in the area: septic tanks, municipal wastewater treatment plants, urban runoff, rural runoff, and pollutant loadings from the Upper Fox and Wolf Rivers. The water quality problems of the Winnebago Pool are the cause of some of the problems in the Lower Fox River and in Lower Green Bay. (Fazio-Omniplan)
W85-00827

FISHES OF AN URBAN STREAM; THE BRONX RIVER, NEW YORK

Hudsonia Ltd., Annandale, NY. R. E. Schmidt and J. M. Samaritan.
Northwestern Environment Science, Vol. 3, No. 1, p. 3-7, 1984. 3 Fig., 1 Tab, 26 Ref. Public Health Service, Biomedical Research Support Grant 5S07RR07150.

Descriptors: *Bronx River, *New York, *Urban streams, *Urban areas, *Stream fisheries, Electro-shocker, Seine, Substrates, Benthos, Fish populations, Species Diversity, Killfish, Darter, Eel, Water pollution effects.

Fish were collected from the urbanized Bronx River (New York) using a backpack electro-shocker and a seine in 1979 at 16 stations along the river's length. Of seventeen species of fish in eight families collected, only one (Fundulus heteroclitus) was collected at all stations; the tessellated darter (Etheostoma olmstedi) and the American eel (Anguilla rostrata) were almost as widely distributed. These three species are considered pollution tolerant. The longitudinal distribution of fishes does not follow the pattern seen in unimpacted streams. Downstream increase in species' numbers was partially due to replacement, rather than entirely by addition. Comparison with the few other urban streams studied by others suggests the hypothesis that downstream replacement of species is typical of urban streams. In the Bronx River, untreated sewage and sand deposition were correlated with alterations in the species composition in the lower river. Sand substrates are too unstable to support the benthic communities necessary for subsistence of diverse fish communities. A high percentage of introduced and exotic fishes were also typical of the Bronx River fauna. (Collier-IVI)
W85-00935

FLUX OF ALIPHATIC AND POLYCYCLIC AROMATIC HYDROCARBONS TO CENTRAL PUGET SOUND FROM SEATTLE (WEST POINT) PRIMARY SEWAGE EFFLUENT

Washington Univ., Seattle, Coll. of Ocean and Fishery Sciences, R. C. Barrick.
Environmental Science and Technology, Vol. 16, No. 10, p. 682-692, October 1982, 2 Fig., 5 Tab, 45 Ref.

Descriptors: *Hydrocarbons, *Wastewater pollution, *Storm wastewater, Primary wastewater treatment, Wastewater treatment, *Aliphatic hydrocarbons, *Aromatic hydrocarbons, *Polynuclear aromatic hydrocarbons, Municipal wastewater, Seattle, *Washington, *Puget Sound, Storm runoff, Runoff, Combined sewer overflows, Fallout, Water pollution sources, Fate of pollutants, Alkanes, Urban runoff.

Primary municipal wastewater discharging into Puget Sound from the METRO sewage treatment facility at West Point (Seattle), Washington, contributed 475 metric tons per year of aliphatic hydrocarbons and 1 metric ton per year of 3-7 ring polynuclear aromatic hydrocarbons (PAH). This corresponded to a per capita loading of 2.6 g and 0.005 g per day, respectively. The ratio of particulate to dissolved aliphatic hydrocarbons was 4:1. Both fractions had similar compositions, with n-alkanes of C22 or less

dominating. Isoprenoid alkanes, n-alkyl cyclohexanes, steroid hydrocarbons, tri- and diterpenoid hydrocarbons, and unidentified C21-C32 branched alkanes were also found. The major source of the aliphatic hydrocarbons was undergraded fuel oils. Aromatic hydrocarbons were dominated by phenanthrene and its methyl and dimethyl derivatives (particulate fraction) and 1,1'biphenyl-3-ol (dissolved fraction). A major source of the PAH compounds was street runoff which contains dust, road wear particles, and automotive oil and grease. The municipal wastewater constituted ⅔ of the total alphatic hydrocarbon discharging into Puget Sound. Other sources were combined sewer overflows, urban runoff, atomspheric fallout, and discrete discharges from ships and industries. Although PAH inputs are less well defined, municipal wastewater is an important source as well as Storm water and combined sewer overflows and atmospheric fallout. In Puget Sound surface sediments accumulations of resolvable alkanes were negligible; phenanthrene plus an unresolved complex mixture, partial; and PAH of 4 or more, substantial. (Cassar-FRC)
W83-01762

GRASSY SWALES PROVE COST-EFFECTIVE FOR WATER POLLUTION CONTROL

Post, Buckley, Schun and Jernigan, Inc., Tampa, FL. W. C. Kercher, Jr., J. C. Landon, and R. Massarelli.
Public Works, Vol. 114, No. 4, p. 53-54, April 1983. 1 Fig., 3 Tab.

Descriptors: *Storm runoff, *Flood control, *Grassed waterways, *Grassy swales, Grasses, Water pollution control, Urban areas, Suburbs, Stormwater, Mosquitoes, Rockledge, Florida.

Evidence that grassy swales are cost effective for reducing stormwater runoff and for achieving water quality and control objectives is presented. The test site encompassed 12.7 acres of a single family residential subdivision located in rockledge, Florida. It contains 41 single family homes, 10 vacant lots, no construction activity and portions of three roads. The soils are Myakka, Urban and Canaveral. Thirteen storm events were available for study. The grassy swale system removed 99% of the pollutants measured. In comparison with a residential drainage system in a neighboring community, the swale system greatly reduced off-site stormwater runoff. The swale system was less expensive to construct, required a smaller percentage of land area and requires less maintenance by local gove7nments. Mosquito breeding in properly designed and maintained residential grassy swales will be minimal, as there will be no standing water. (Baker-IVI)
W84-02354

HYDROLOGICAL AND ENVIRONMENTAL CONTROLS ON WATER MANAGEMENT IN SEMIARID URBAN AREAS — PHASE II

Arizona Water Resources Research Center, Tucson, AZ. S. D. Resnick, K. J. DeCook and R. A. Phillips.

Available from the National Technical Information Service, Springfield, VA 22161 as PB83-202382, Price codes: A16 in paper copy, A01 in microfiche. Water Resources Research Center Completion Report, March 1983. 355 p., 58 Fig., 64 Tab, 58 Ref, 5 Append. OWRT B-023-ARIZ(7), 14-34-0001-3556.

Descriptors: *Urbanization, *Semi-arid areas, *Rainfall-runoff relationships, Water quantity, Water quality, Rainfall, *Storm runoff, Economic feasibility, artificial recharge, Water resources planning, Urban watersheds, *Arizona, Tucson, Institutional constraints, Legal aspects, Social aspects.

Rainfall and runoff studies initiated by the University of Arizona provide data for three small urban watersheds from 1968 and one rural watershed from 1957 to 1969. Annual precipitation of about 11 inches produces annual runoff ranging from 0.44 inches in depth for the rural watershed and 1.0 to 2.10 inches for the urban watersheds. There is about a four to five-fold increase in average yearly storm runoff volume and unbanization in the Tucson area. Water samples collected on a lumped basis show generally high concentrations of suspended sediment, bacterial loading, and dissolved organics. Initial field treatment and exploratory laboratory studies of treatment methods indicate that three days is an optimal length of concentrations. Multi-purpose urban storm runoff management systems can be developed to control floods while at the same time maintaining waterbased linear parks along minor stream channels in semiarid regions. Multi-purpose systems are more economical than the single-purpose systems required to accomplish the same purposes. Further studies are needed to characterize the quality of storm runoff from selected urban land use areas with a view toward on-site control and disposal.
W83-02918

INFLUENCE OF COMBINED SEWAGE OUTFALL ON THE CHEMICAL AND BIOLOGICAL QUALITY OF SALT CREEK, PORTER COUNTY, INDIANA

Indiana Univ. Northwest, Gary, IN, Dept. of Biology. R. L. Whitman.
Proceedings of the Indiana Academy of Sciences, Vol. 92, p. 275-282, 1982. 4 Fig., 14 Ref.

Descriptors: *Wastewater outfall, *Water quality, Indiana, Porter County, Salt Creek, Salmon, Ammonia, Acidity, Nitrates, Phosphates, Sulfates, Chlorides, Sediments, Oxygen demand, Dissolved oxygen, Valparaiso.

Analyses of dissolved oxygen, specific conductance, pH, Ammonia, nitrate, total phosphate, sulfate, chloride sediment oxygen demand and organic content and biological species diversity during July, August, September of 1980 and April of 1981 of Salt Creek waters indicated that the Valparaiso Combined Sewage Outfall (CSO) was the ma-

jor contributor to the degradation of the stream's water and sediment quality. Little evidence of organic and sediment loading from agricultural practices was noted. Sand mining operations at the headwaters of Sager Creek above Sagar Lake may significantly impact upstream ecosystems and potential salmon spawning areas. An undocumented sewage outfall between Horse Prairie Road and U.S. Highway 30 is strongly suspected although water quality data obtained here was inconsistent. In spite of heavy pollution imposed on the stream by these point sources, the stream at base flow conditions appeared capable of limited recovery about 9.0 to 12.6 km downstream of the Valparaiso CSO. The heaviest pollution, unfortunately, took place at stream locations with the greatest salmon spawning potential. Diurnal analyses indicated that episodes of significant rainfall concided with anerobic conditions in areas downstream of the Valparaiso CSO and with depressed oxygen levels as far north as the State Highway 6 station. Under these conditions of water quality, possible sediment loading from sand mining operations, and limited suitable spawning substrates, it is unlikely that Salt Creek's potential as a salmon fishery will improve. (Baker-IVI)
W84-05310

INFLUENCE OF RAINFALL CHARACTERISTICS ON THE POLLUTION EMISSION

DHV Consulting Engineers, Amersfoort (Netherlands). K. Bakker and H. S. J. van Wieringen.

Water Science and Technology, Vol. 16, No. 8/9, p. 285-295, 3 Fig., 3 Tab, 6 Ref.

Descriptors: *Water pollution sources, *Storm wastewater, *Rainfall impact, *Combined sewers, Combined sewer overflows, Storm runoff, Sewers, Storage reservoirs, Runoff coefficient, Overlow, Urban hydrology, Urban runoff, Biological oxygen demand, Chemical oxygen demand, Suspended solids.

An extensive data collection program has been implemented in the Netherlands which provides data on quantities and qualities of stormwater discharges from sewer systems into surface water. To protect the quality of surface waters the combined sewer system is designed to act as a storage reservoir; overflows are restricted by enlarging the storage capacity of individual sewers which is accomplished by over dimensioning of individual sewers. Virtually all sewers in the Netherlands are situated below the level of the overflow weir. Each catchment studied is equipped with continuously recording rain and water level gauges. The measurements started in 1981 at the combined sewer system of Loenen and were later started at other locations. Run-off coefficients were derived from water balances for various storms and show a distinct seasonal influence. In winter time, the coefficients related to impervious area appear to be higher than 1.0. During summer, coefficients considerably below 1.0 have been found. The emission of suspended solids appears to depend on rainfall characteristics. The time of filling of the sewer system reflects these characteristics and appears to be decisive for the concentrations of the suspended solids at the beginning of an overflow. The same holds true for BOD and COD. Long filling times result in much lower concentrations as compared to short filling times. Suspended solids concentrations during an overflow could be predicted by taking into account the washout of the pollutants and the discharge at the overlow weir. (Collier-IVI)
W85-01697

INFLUENCE OF SURFACE RUNOFF ON THE MACRO-INVERTEBRATE FAUNA OF AN URBAN STREAM

Middlesex Polytechnic, London (England) R. B. E. Shutes.

Science of the Total Environment, Vol. 33, p. 271-282, February, 1984. 5 Fig., 1 Tab, 16 Ref.

Descriptors: *Runoff, *Water quality control, *Water pollution sources, Storm water, Fauna, Macroinvertebrates, Invertebrates, Streams, Silk Stream, Dean's Brook, London, England, Highways, Population dynamics, Spatial distribution.

Hydrobiological indices were applied to samples of the macro-invertebrate benthos from an urban stream. A range of physico-chemical parameters from water samples were also determined. The water quality of Silk Stream and its tributary, Dean's Brook, determined by processing macroinvertebrate data with the Trent Biotic Index, Chandler's Score system and Community Diversity Index, deteriorated from a fairly clean to a severely polluted state within a distance of six kilometers. The Community Diversity Index was predicted from physico-chemical data by multivariate analysis and was found to be similar to the observed diversity index for fairly clean and moderately polluted conditions but was dissimilar for severe pollution occurrences. Although the specific influence of street runoff was not totally satisfactorily demonstrated by the intermittently collected physico-chemical data, the spatial and temporal variation in macro-invertebrate numbers and species noted in the study do provide a basis for a first order evaluation of storm runoff on urban channel ecology. (Baker-IVI)
W85-00749

INFLUENCE OF URBAN RUNOFF ON THE WATER POLLUTION OF THE VISTULA IN THE REGION OF CRACOW AGGLOMERATION

Instytut Ksztaltowania Strodowiska, Krakow (Poland) I. Skoczen.

Acta Hydrobiologica, Vol. 23, No. 3, p. 195-210, 1981. 3 Fig., 5 Tab, 13 Ref.

Descriptors: *Vistula, *Krakow, *Poland,, *Urban runoff, *Water pollution sources, Urban areas, Biochemical oxygen demand, Precipitation, Pollution load, Rainfall runoff.

The Vistula in the Krakow area has an unacceptable level of pollution. Investigations on the influence of urban runoff on the Vistula in the Krakow urban area (agglomeration) were carried out from 1971 to 1976 in 69.1 km of the river course. The BOD5 index was adopted as the basis for the investigation. About 1500 BOD4 determinations were made during the six years of the investigation. The annual set of concentrations and loads is not homogenous and does not exhibit a normal distribution. The results obtained during a year were arranged into sets according to meterological and hydrobiological criteria. A statistical analysis of the set for dry periods showed that the results are homogenous and exhibit a normal distribution; sets of loads for precipitation periods do not exhibit a normal distribution. The lowest pollutant load (about 7 thousand tons/years) was found in 1973, a year with low total precipitation. The highest pollutant loads (about 19 thousand tons/year and 17 thousand tons/year) were found in 1974 and 1975, years with high total precipitation. Runoff pollution constituted from 30 to 50% of the total pollution of the Vistula. (Moore-IVI)
W85-00222

INVERTEBRATES AND URBAN RUNOFF IN A SMALL NORTHERN STREAM, EDMONTON, ALBERTA, CANADA

Alberta Univ., Edmonton. Dept. of Zoology, E. R. Whiting and H. F. Clifford.
Hydrobiologia, Vol. 102, No. 1, p. 73-80, May, 1983. 8 Fig., 2 Tab, 25 Ref.

Descriptors: *Invertebrates, *Urban runoff, *Edmonton, *Alberta, *Canada, Environmental effects, chemical properties, Species diversity, Bioindicators.

The invertebrate fauna of a small northern stream was examined within Edmonton, Alberta. Many invertebrates that were common upstream of the city were absent or rare within the city. In contrast, some tubificids and chironomids were very abundant within the city. Diversity and richness (number of taxa) of the fauna were much lower within Edmonton than upstream, while the total density was much higher within the city. These changes in the urban invertebrate fauna were apparently caused by the discharge of organic materials and silt from storm sewer runoff. Chemical analysis of routinely-collected water samples did not show significant differences between urban and nonurban sites. This was probably due to the sporadic nature of storm sewer runoff. Peak levels of contaminants in the stream were usually missed because of the routine nature of sampling. Aquatic invertebrates, which exhibit long-term responses to sporadic runoff incidents, provided a better indication of stream water quality than did routine chemical monitoring. (Author's abstract)
W84-04716

LONG ISLAND SEGMENT OF THE NATIONWIDE URBAN RUNOFF PROGRAM

Long Island Regional Planning Board, Hauppauge, NY, L. E. Koppelman.
December 1982. 134 p., 32 Fig., 75 Tab, 49 Ref., 8 Append.

Descriptors: *Urban runoff, *Recharge basins, *Sediment, *Storm water, *Runoff cycles, *Pollution load, Runoff, Natural recharge, Replenishment, Nonpoint pollution sources, Storm runoff, Urban watersheds, Vegetation effects, *New York, Long Island.

The question of whether the continued use of the Long Island recharge basin, a device for the disposal of runoff and its recharge to groundwater, poses a threat to the quality of the bi-county water supply has caused increasing concern. There was some evidence that the basins were also devices for the concentration of pollutants in runoff and their swift transmission to Long Island's only source of water supply. The results of an investigation into these questions have proved to be largely positive. Coliform and fecal streptococcal bacteria were found in runoff but not in the groundwater beneath the recharge basins. The concentrations of other pollutants, which were generally relatively low in runoff, were even lower in the groundwater beneath the basins. It appears that infiltration through the soil is an effective mechanism for the attenuation of some of the heavy metals and organic compounds. These findings were as true for the unlined basins as for the recharge basin at Center-each, which was built with a plastic lining. It also appears that, contrary to the the widely held view, the removal of vegetation from the basin floor is not necessary, and that the vegetation may actually facilitate the infiltration of storm waters. The findings indicate that some control measures are complex, costly and of questionable effectiveness, and that preventative action precluding degradation is preferable. (Garrison-Omniplan)
W85-00058

MERCER COUNTY STORMWATER TOXICS MANAGEMENT PROJECT: DELAWARE AND RARITAN CANAL CONDUIT SPECIAL STUDY, RENTON, NEW JERSEY

Mercer County Planning Div., Trenton, NJ, New Jersey Department of Environmental Protection and Mercer County Water Quality Planning Program, Final Report, 1982. 115 p., 11 Fig., 28 Tab, 48 Ref., 3 Append.

Descriptors: Water quality, *Water quality management, *Storm runoff, *Storm sewers, *Urban runoff, *Chemical analysis, *Pollutants, Canals, Drainage effects, Drainage water, Biochemical oxygen demand, Hydrocarbons, Heavy metals, Polychlorinated biphenyls, Pesticides, Biological samples, Benthic fauna, Enforcement, *New Jersey, Trenton, Mercer County.

A 2-year study of stormwater runoff in the Trenton, New Jersey area determined the nature and extent of toxic substances entering the Delaware and Raritan Canal, which is extensively used for boating, fishing, swimming, and drinking water supply. Earlier studies had detected toxic pollutants, such as heavy metals, polychlorinated biphenyls, and pesticides in Canal sediments, which were suspected to be entering the Canal through Storm sewer discharges. Physical, chemical, and biological sampling and analyses substantiated the need to properly manage the quality of stormwater runoff entering valued water resources. The methodology was based on Mercer County's earlier "stream surveillance" studies. The study found concentrations of biological oxygen demand, total hydrocarbons, and heavy metals in urban stormwater runoff similar to those reported in the literature. Cadmium, cipper, lead and zinc were the predominant heavy metals found. Highway runoff contained lower levels of contamination than urban stormwater runoff. Stormwater runoff from urban residential as well as industrial and commercial areas contained high levels of contamination. Biological surveys identified the greatest effects of pollution nearest the inlet and outlet of the Trenton Conduit. Concentrations of existing contaminants in sediments appeared to be highly localized. Several monitoring and inspection programs are recommended to track the quality of reclining waters, drinking waters and pollutants. (Fazio-Omniplan)
W84-00802

METHODS FOR CALCULATION OF ANNUAL AND EXTREME OVERFLOW EVENTS FROM COMBINED SEWER SYSTEMS

Technical Univ. of Denmark, Lyngby. Dept. of Sanitary Engineering. N. B. Johansen, P. Harremoes, and M. Jensen. Water Science and Technology, Vol. 16, No. 8/9, p. 311-325 , 1984. 9 Fig., 4 Tab, 14 Ref.

Descriptors: *Urban runoff, *Overflow, *Combined sewer systems, *Rainfall-runoff relationships, Water pollution sources, Statistical analysis, Urban hydrology.

Overflow from combined systems constitute and increasing source of pollution of receiving waters, as compared to daily wastewater discharges which undergo treatment to a still higher extent. The receiving water problems from overflows are significant both in a long term scale (mean annual load) and in a short term scale (extreme event load). A method for computation of both annual and extreme load was developed based on historical rain series and the use of a time-area model and simple pollutant mixing model in runoff calculation. Statistical calculations for both mean annual load and extreme events have been applied to the computed overflow series. Based on the computerized method simple manual calculation methods have been developed, resulting in graphs and tables for annual load and extreme load. (Author's abstract)
W85-01699

MUTAGENIC ACTIVITY OF ORGANIC MATTER IN AN URBAN RIVER SEDIMENT

Suzuki, J; Sadamasu, I; Suzuki, S. (Univ. of Tokyo, Japan). Environmental Pollution, Series A: Ecological and Biological; 29: No. 2, p. 91-99 (Oct 1982).

Sediment organic matter from the upper and lower reaches of an urban river, the Tama, were systemically fractionated by solvent extraction and silica gel column chromatography. The mutagenic activities of these fractions were assayed by the Ames's method using strains TA98 and TA100 of Salmonella typhimurium. Strong mutagenic activity was observed for the fractionated extracts not only in the lower river sediment but also in the upper river. The basic and neutral water extracts were especially mutagenic. The total mutagenicity of the lower river sediment, which was estimated from the sum of mutagenicities of all fractions, was about ten times higher than that of the upper river sediment because the lower river sediment contained a large amount of organic matter. The thin-layer chromatograms of the fractions indicated that the mutagenicity of the sediment was attributable primarily to polar mutagenic compounds rather than polycyclic aromatics.

MUTAGENIC ACTIVITY OF RUNOFF AND LEACHATE WATER FROM HAZARDOUS WASTE LAND TREATMENT

Texas A and M Univ., College Station, TX, Dept. of Soil and Crop Sciences. K. W. Brown and K. C. Donnelly. Environmental Pollution (Series A), Vol. 35, No. 3, p. 229-246, 1984. 2 Fig., 6 Tab, 25 Ref. EPA grant R.805474010.

Descriptors: *Mutagens, *Hazardous wastes, *Land disposal, *Leachates, Sludge, Runoff. Water pollution sources, Oil industry, Industrial wastes, Bioassay.

The mutagenic potential of runoff and leachate water from petroleum sludge-amended soils was determined using the Salmonella microsome assay and the Bacillus subtils DNA repair assay. The runoff and leachate samples were collected from four different soils amended with an API-separator sludge from either a petroleum refinery or a petrochemical plant. While mutagenic activity was detected in limited number of runoff and leachate samples, greater amounts of mutagenic activity were detected in the runoff water. The majority of samples which were toxic to Salmonella at low dose levels induced increased lethal damage to DNA repair-deficient strains of B. subtilis. Generally, the mutagenic activity of leachate water and the runoff water from two of the three soils decreased with time following waste application. The activity in the third soil did not decrease over the 3 years of observation. The amounts of activity released from the soil in the leachate and runoff water were small compared with other environmental exposures, indicating that while land treatment may allow some release to the environment, the impact is likely to be small. The results also indicate that microbial

bioassays may prove to be a useful tool environmental monitoring of land treatment facilities. (Author's abstract)
W85-02588

NATIONWIDE ASSESSMENT OF URBAN RUNOFF IMPACT ON RECEIVING WATER QUALITY

Florida Water Resources Research Center, Gainesville, FL, J. P. Heaney and W. C. Huber.
Water Resources Bulletin, Vol. 20, No. 1, p. 35-42, February, 1984. 2 Fig., 5 Tab, 14 Ref. EPA grant 805663.

Descriptors: *Urban runoff, *Combined sewer overflows, *Environmental effects, *Water quality, Water pollution effects, Fish kills, Beaches, Dissolved oxygen, Storm runoff.

Urban stormwater runoff has been recognized as a potential major contributor of pollution to receiving waters. However the projected high costs of control have prompted an examination of the extent to which these impacts have been documented. A nationwide search was conducted for case studies demonstrating a cause-effect linkage between urban runoff and impairment of beneficial uses in receiving waters. Documented case studies of impacts of urban runoff and combined sewer overflows on receiving water are scarce. Impacts of other discharges make the impacts of urban runoff, and the expected impacts from urban runoff are relatively subtle. The existence of numerous definitions of the word "impact" make it difficult to devise meaningful rankings of impacts. No clear line of demarcation exists to distinguish the urban drainage system from the receiving water, especially for small creeks and ponds. Some evidence exists that urban runoff is a cause of fish kills and beach closings. The studies of dissolved oxygen records downstream of urban areas have produced the most definitive information regarding the impact of wet weather flows. Stormwater discharges dampen the diurnal fluctuations in dissolved oxygen levels. If receiving water impacts are to be evaluated for environmental decision making, then a problem solving framework is needed (Moore-IVI)
W84-04102

OIL AND GREASE IN URBAN STORMWATERS

California Univ., Los Angeles, School of Engineering and Applied Science. M. K. Stenstrom, G. S. Silverman, and T. A. Bursztynsky. Journal of Environmental Engineering, Vol. 110, No. 1, p. 58-71, February, 1984. 3 Fig., 9 Tab, 30 Ref.

Descriptors: *Oil, *Grease, *Storm water, *Water pollution sources, *Land use, Rainfall, Water pollution control, Simulation, Richmond, California, San Francisco Bay.

A study of oil and grease in urban stormwaters was performed on a small watershed in Richmond, California, with the objective of determining the amount of oil and grease discharged into San Francisco Bay. Five sampling stations were selected at various places in the watershed that were indicative of specific land uses, and runoff from seven storms was sampled and analyzed. The results of the survey indicated that oil and grease concentration was highly dependent upon land use, ranging from 4.1 mg/L in residential areas to 15.3 mg/L in parking lots. A statistical analysis of oil and grease discharged was proportional to total rainfall. Qualitative analysis of the oil and grease by gas chromatography indicated that it most resembled used automobile crankcase oil. Several samples showed evidence of spills of specific compounds. A simulation of management techniques indicated that a 90% reduction in discharge from commercial properties and parking lots, which represented only 9.6% of the total surface area, would result in a 53% reduction in total oil and grease discharge. Growth simulation predicted a potential 27% increase in discharge if 5% of the watershed were converted from open land to commercial property. (Author's abstract)
W84-03470

PARTICLE-SIZE DISTRIBUTION AND PHOSPHORUS LEVELS IN SOIL, SEDIMENT, AND URBAN DUST AND DIRT SAMPLES FROM THE MENOMONEE RIVER WATERSHED, WISCONSIN, U.S.A.

Wisconsin Univ.-Madison. Dept. of Soil Science, A. Dong, G. V. Simsiman, and G. Chesters.
Water Resources, Vol. 17, No. 5, p. 569-577, May, 1983. 1 Fig., 3 Tab, 11 Ref. EPA grant R005142.

Descriptors: *Phosphorus, *Particle size, *Water pollution sources, Sediments, Soil type, Urban areas, Suspended sediments, Roads, Nonpoint pollution sources, Wastewater treatment plant, Wisconsin, Menomonee River Watershed.

Soil bottom sediment, suspended sediment, and urban street dust and dirt samples from the Menomonee River Watershed, Wisconsin, were dispersed by ultrasound, fractionated and analyzed for the P content of each of three particle-size fractions. The major soil types in the watershed were used as a reference for comparing particle-size distribution and P content in urban street dust and dirt, and in sediments. Phosphorus level was found to be greater in the clay-sized particles than in the sand- or silt-sized particles of urban street dust and dirt samples, but 48% of the P was in the sand-sized fraction because of the predominance of sand-sized particles in these samples. The highest P level in the clay-sized fraction of the bottom sediments occurred at the site below a sanitary treatment plant (STP) outfall with secondary treatment capability. The P level found below a tertiary STP outfall was equal to the level found in agricultural areas. When using P level in sediment for locating areas of possible P input to the river, the clay-sized fraction of bottom sediments was more precise than P levels in unfractioned samples. (Author's abstract)
W84-01674

PETROLEUM HYDROCARBONS IN URBAN RUNOFF FROM A COMMERCIAL USE AREA

Rhode island Univ., Kingston, RI, Graduate School of Oceanography. E. J. Hoffman, J. S. Latimer, G. L. Mills, and J. G. Quinn.

Journal of the Water Pollution Control Federation, Vol. 54, No. 11, p. 1517-1525, November, 1982. 6 Fig., 9 Tab, 27 Ref.

Descriptors: *Hydrocarbons, *Urban runoff, *Storm water, Runoff, Fate of pollutants, Water pollution sources, Rain storms, Suspended solids, Particulate matter, Paving, Oil pollution, *Rhode Island.

Petroleum hydrocarbons were determined in storm runoff from a shopping mall in Warwick, Rhode Island. The samples were collected during 6 rainstorms lasting from 1.5 to 1.3 hours and depositing 0.05 to 1.60 inches of rainfall. The loads of suspended solids (SS) and hydrocarbons varies widely over the progress of a storm, highest concentrations and loads being associated with the first flush (first major peak in flow rate). SS concentrations (in mg per liter) ranged from 1.6 to 12.0 minimum and 47.5 to 252.0 maximum (flow weighted means, 20.5-112.7 mg per liter). Total hydrocarbons concentrations (mg per liter) were: 0.059-0.450 minimum to 1.13-5.70 maximum (flow weighted means, 0.69-2.15). Loading was essentially linear with total rainfall, suggesting that the supply of pollutants had not been exhausted in storms up to the largest (1.60 in) but could approach a limit in storms > 1.90 in. Between 83 and 93% of total, hydrocarbons were associated with the particulates. These solids contained 1.7-33% hydrocarbons. Gas chromatographs of the runoff hydrocarbons and automotive crankcase oil were very similar. (Cassar-FRC)
W83-02281

PREDICTIVE ACCURACY DETERMINANT APPLIED TO A LINEAR MODEL PHOSPHORUS LOADING RESULTING FROM URBAN RUNOFF

Louisiana State Univ., Baton Rouge, Dept. of Civil Engineering. R. F. Malone, H. Saidi, and K. Wegener.
Applied Mathematical Modelling, Vol. 8, No. 2, p. 81-88, April, 1984, 7 Fig., 3 Tab, 14 Ref.

Descriptors: *Mathematical models, *Urban runoff, *Phosphorus, Pollution load, Simulation, Prediction, Storm runoff, Water quality.

A case study of the application of an iterative technique for determination of predictive accuracy is presented. The method uses Monte Carlo simulations and split sampling techniques to verify model accuracy. Examination of the ability to project total phosphorus loadings reveals the sensitivity of the model to calibration procedures. Predictive reliability was found to vary widely as the number of rainfall events considered in the calibration process changed. Predictive reliability was substantially increased by imposing calibration constraints which ensured that a wide distribution of values of the independent variable were represented in the calibration pool. Although the linear model is theoretically weak in its representation of the runoff loading phenomenon, it displays relatively stable predictive capabilities which warrant its consideration for use in management studies. The predictive errors associated with loading projections limit the linear model's value to applications insensitive to errors in the loading projections for individual storm events. This study provides further evidence of the need to consider uncertainties associated with the modelling of water quality phenomena. (Author's abstract)
W84-04768

PRELIMINARY FINDINGS OF THE PRIORITY POLLUTANT MONITORING PROJECT OF THE NATIONWIDE URBAN RUNOFF PROGRAM

Dalton-Dalton-Newport, Inc., Cleveland, OH. R. H. Cole, R. E. Frederick, R. P. Healy, and R. G. Rolan
Journal of the Water Pollution Control Federal, Vol. 56, No. 7, p. 898-908, July 1984, 1 Fig., 7 Tab, 10 Ref.

Descriptors: *Monitoring, *Pollutant identification, *Organic compounds, *Urban runoff, *Metals, Pentachlorophenol, Copper, Lead, Zinc, Cadmium, Path of pollutants.

Twenty-four pollutants were detected in at least 10% of the urban runoff samples. These were selected for further evaluation and consideration of their implications in water quality protection and maintenance. The organic priority pollutants found most frequently in the predominantly residential and commercial area samples pose little risk to humans at detected levels. The predominant pathway for human exposure to the organics associated with gasoline is through ingested food and inhalation, so that contaminated surface water should pose little risk at the levels measured in Nationwide Urban Runoff Program (NURP) samples. Some of the priority pollutant metals in urban runoff could represent a potential risk to human health. The noncarcinogenic human health criteria, drinking water standards, and human health criterion of 13.4 micro g/liter in 30% of the samples. Arsenic concentration in undiluted runoff frequently exceeded the EPA human carcinogenic criterion. Because most storms last between 2 and 16 hours, the most meaningful measure of potential aquatic life effects is a comparison of pollutant concentrations with acute water quality criteria and toxicity values. If pollutant levels exceed these values before dilution, than aquatic species are likely to be impacted in the mixing zone. Pentachlorophenol was the only organic priority pollutant to exceed freshwater acute aquatic life criteria. Four priority pollutant metals, Cd, Cu, Pb, and Zn, exceeded freshwater acute aquatic life criteria in 9 to 50% of the samples. (Baker-IVI)
W85-01661

PROBLEMS, ISSUES, CONSTRAINTS, AND BARRIERS TO WATER QUALITY PLANNING AND MANAGEMENT IN URBAN AND URBANIZING AREAS (SMSA'S) IN TENNESSEE

Tennessee Univ., Knoxville, TN, Graduate School of Planning. G. E. Bowen, G. E. Ferguson, and T. R. Gangaware. Available from the National Technical Information Service, Springfield, VA 22161 as PB83-196519, Price codes: A10 in paper copy, A01 in microfiche, Water Resources Research Center Research Report No. 90, Univ. of Tennessee, Knoxville, March 1983. 204 p., 8 Fig., 7 Tab, 23 Ref. 2 Append. OWRT A-062-TENN(1), 14-34-0001-1145.

Descriptors: Water quality management, *Urban planning, *Institutional constraints, *Tennessee, Urbanizing areas, Literative reviews, *Surveys, Urban runoff, Low flows, Toxic substances, Industrial wastes, Abandoned dump sites.

Results are presented of a statewide study based on the systematic gathering of information on water quality management issues, problems, and barriers from three sources: a literature review, a questionnaire sent to experts within the state, and five case studies of "208" agencies within Tennessee. The study points out considerable variation among water basins, related to both water quality and the causes and treatment of problems. The major problems identified were: erosion and sediment, agricultural and forest runoff, sludge, flooding, construction runoff, low dissolved oxygen, flood plain development eutrophication, algal growth and contamination from hazardous wastes. The major issues and barriers identified were: resistance to government regulations, lack of understanding regarding cause/effect relationships, imbalance between economic developement and environment protection, low priority of water quality, poor cooperation between industry and government agencies weak enforcement of regulations, and the need for stronger legislation. Major problems identified for metropolitan areas include: urban and construction runoff, low stream flows, toxic substances, abondoned dumps, and industrial contaminants. The barriers to obtaining high quality streams in metropolitan areas include: inadequate financial support, lack of political commitment, and well organized and financed opposition to water quality management. In addition, management agencies were fragmented, urban and rural conflicts existed, and suburban growth is poorly controlled.
W83-02899

PROTECTION OF GROUNDWATER FROM OIL POLLUTION IN THE VICINITY OF AIRPORTS

J. Svoma and V. Houzim. Environmental Geology and Water Sciences, Vol. 6, No. 1, p. 21-30, 1984. 7 Fig., 3 Tab, 12 Ref.

Descriptors: *Groundwater pollution, *Airports, *Water pollution control, Hydrocarbons, Groundwater, Oil pollution, Water pollution sources.

The potential danger to the quality of groundwater close to airports is due to a combination of several ecological unfavorable factors. Airports are usually situated in the proximity of a groundwater divide, or in wide valleys. Causes of pollution include the sheer volume of fluid being handled constantly, the physicochemical properties of hydrocarbons, and technical errors in the transport and storage of fuels. Oil hydrocarbons in concentrations of tenths to units of milligrams per liter have been found in snow in the vicinity of runways. Carcinogenic benzopyrenes are accumulated in soil. Oil hydrocarbons spread in rock formations as a separate layer as well as in solution. In porous permeable formations, pollution by a free product affects areas on the order of tens of meters, while hydrocarbons in solution penetrate to distances of hundreds of meters or even kilometers. Fissured rocks are cause for even more complex conditions for the spreading of oil based substances. Preventive protection of groundwater and mineral waters using monitoring devices is being carried out at some major airports. Observation wells situated in the tectonic zone can also be used for reparative pumping. (Baker-IVI)
W85-02859

QUALITY OF RUNOFF FROM MODEL COAL-PILES

Stahl, R. G.; Davis, E M. Journal of Testing and Evaluation; 12: No. 3, p. 163-170 (May 1984).

Four different coals were tested under controlled laboratory conditions of simulated rainfall events over a 120-day period to determine some of the changes in the quality of the runoff. Theses lignite coal-pile runoffs were analyzed for thirteen standard water quality parameters. This Research demonstrated some of the qualities of runoff that may be expected from stockpiles of these four representative coals.

QUALITY OF RUNOFF FROM SMALL WATERSHEDS IN THE TWIN CITIES METROPOLITAN AREA, MINNESOTA — HYDROLOGIC DATA FOR 1980

Geological Survey, St. Paul, MN. Water Resources Div. G. A. Payne, M. A. Ayers, and R. G. Brown.
Available from the USGS, OFSS, Lakewood CO 80225. Price: $37.75 in paper copy, $3.50 in microfiche. USGS Open-File Report 82-504, 1982. 289 p., 7 Fig., 17 Ref.

Descriptors: *Storm runoff, *Urban runoff, *Agricultural runoff, *Small watersheds, Urban hydrology, Land use, Storm water, Storm drains, Precipitation (Atmospheric), Antecedent precipitation, Rainfall intensity, Rain gages, Water quality, Twin Cities metropolitan area, *Minnesota.

An investigation of non-point-source runoff from small watersheds in the Twin Cities metropolitan area was conducted to define relationships between land use, watershed characteristics, and the quantity, quality, and timing of runoff. Six rural and four urban watersheds ranging in size from 1.22 to 82.9 square miles were studied. Discharge and water quality data were collected at 19 sites during 1980. Recording instruments and automatic samplers provided continuous discharge records at 17 sites, continuous rainfall records and automatic collection of samples at 12 sites, and wetfall/dryfall precipitation samples at six sites. Samples was intensified during periods of increased runoff resulting from snowmelt and rainstorms. Primary emphasis was placed on analysis of samples for suspended solids,

nutrients, and chemical oxygen demand. Samples were also analyzed for chloride, metals, bacteria, and pesticides. The data are documented in tables containing basin characteristics and land use, daily and unit values for discharge and rainfall, rainfall characteristics, water-quality data for runoff and precipitation, results of laboratory settling test, results of quality assurance tests, daily loads, and storm loads. (USGS)
W84-00982

QUANTITATIVE MODELS AND ANALYSIS OF URBAN NONPOINT SOURCE WATER POLLUTION CONTROL SYSTEMS

Georgia Inst. of Tech., Atlanta, GA, School of Industrial and Systems Engineering.A. O. Esogbue.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-214940, Price codes: A10 in paper copy, A01 in microfiche. Environmental Resources Center Report No ERC 04-83. Georgia Institute of Technology, Atlanta, April 1983. 217 p., 20 Fig., 30 Tab, 55 Ref, 3 Append. OWRT B-147-GA(1), 14-34-0001-0215.

Descriptors: *Algorithms, Best management practices, Evaluation, Fuzzy clustering algorithms, Fuzzy sets, Management, Multilevel hierarchical model, *Nonpoint source water pollution, Public participation, Statistical analysis, Cost effectiveness, *Water pollution control, Systems analysis, *Georgia, Atlanta.

Agencies designated to implement the Clean Water Act of Public Law PS 72-500, Section 208 often encounter difficulties associated with the management of systems consisting of complex interactions of soft and imprecisely stated phenomena. Two such major areas in this implementation process concern the use of the public in water resources plan formulation and the use of the so called best management strategies in the control of nonpoint source water pollution. The quantitative analysis of these systems as well as the development of quantitatively based models for measuring their effectiveness is the subject of the inquiry whose results are reported here. The central thesis is that because of the presence of soft imprecise variables, any qualification efforts should invoke the tools of fuzzy set theory. The prove this point, the goals of State Planning Agencies particularly relative to Erosion and Sedimentation Control were reviewed and the problems inhibiting compliance highlighted. The essentially fuzzy variables and phrases were syphoned out and a plan to minimize the fuzziness developed. The use of the publics in water resources planning was next considered leading to the development of a working definition of their effectiveness. A fuzzy multi-level hierarchical model which provides a pessimistic as well as an optimistic measure of this effectiveness was then developed and validated using the Water Resources Advisory Group of the Atlanta Regional Commission as the Leitmotif. Various fuzzy clustering algorithms were developed to group the field data. This model was also used to analyze the contributions of various hypothesized variables (factors) on the total system effectiveness of public participants and planners. A comprehensive list of BMPs in use in the State of Georgia as well as in the nation was developed and a statistical analysis of their effectiveness performed. Effectiveness was approached both from the system and cost effectiveness perspectives. The total effectiveness of BMPs as a control approach for nonpoint source pollution was assessed using a modification of the fuzzy multilevel model. As in the public participation effectiveness measurement, the contributions of each design principle to total system and cost effectiveness were determined. A statistical analysis of the important and effectiveness of each BMP was also performed leading to a ranking of these BMPs, structural and nonstructural, in terms of their effectiveness.
W83-03184

RUNOFF FROM COAL PILES: EFFECTS ON THE ENVIRONMENT AND THE PUBLIC'S HEALTH

Stahl, R. G., Jr. Houston, TX; Univ. of Texas 91982). 163p. University Microfilms Order No. 83-16, 539.

Thesis (Ph.D.).

The use of coal for fuel in place of oil and natural gas has been increasing in the US. Typically, users store their reserves of coal outdoors in large piles and rainfall on the coal creates runoffs which may contain materials hazardous to the environment and the public's health. To study this hazard, rainfall on model coal piles was simulated, using deionized water and four coals of varying sulfur content. The simulated surface runoffs were collected during 9 rainfall simulations spaced 15 days apart. The runoffs were analyzed. The runoffs from the high-sulfur coals and the lignite exhibited extremes of pH (acidity), specific conductance chemical oxygen demand, and total suspended solids; the low-sulfur coal runoffs did not exhibit these extremes. Without treatment, effluents from these high-sulfur coals and lignite would not comply with federal water quality guidelines. Most extracts of the simulated surface runoffs contained at least 10 organic compounds including polycyclic aromatic hydrocarbons. All extracts were clastogenic. Extracts of runoffs from the high-sulfur coals were both clastogenic and cytotoxic; those from the low-sulfur coal and the the lignite were less clastogenic and not cytotoxic. These data suggest a relationship between the sulfur content of a coal, its mutagenicity and also its clastogenicity.

SEDIMENTARY CHARACTERISTICS OF SUSPENSIONS IN LONDON STORMWATER

Middlesex Polytechnic, London (England). J. B. Illis, R. Hamilton, and A. H. Roberts.
Sedimentary Geology, Vol. 33, No. 2, p. 147-154, 1982. 3 Fig., 17 Ref.

Descriptors: *Sediments, *Storm water, *Urban runoff, Suspended sediments, Storm runoff, London, *United Kingdom, Runoff, Particle size, chemical composition, *Pollutant identification.

The size and composition of suspended solids in urban runoff were studied during 3 storm events in a 420 ha section of London. The particle size distribution (1-60 microns), suspended solids concentrations (maximum 262 mg per liter) rainfall intensity, and antecedent conditions varied widely among the storms. The particle size distribution showed strong bimodality (peaks at 2 and 20 microns) in the 2 summer storms. Smaller particles were dominant in the rising limb of the hydrograph because of flushing from the storm drain system early in the storm. In the third storm the unimodal distribution indicated flocculated or aggregated suspensions, which was confirmed by microscopic studies. Storm water sediments consisted of inorganic grains, organic matter, bacterial slimes, and other particles. Most particles were aggregated. Finer inorganic sediment fractions were dominated by quartz and feldspar, with smaller amounts of mica and chlorite. Little or no clay minerals were present. Chemically, the most common elements were Si and Al, followed by K, Fe, and Ca. Small amounts of Mg, S, Cl, P, and Ti were consistently found. This composition was typical of road dusts. Coarse sediments were rapidly transported through the system, as evidenced by the unaltered physical and chemical natures. (Cassar-FRC)
W83-02451

SIMULATION OF WATER POLLUTION GENERATION AND ABATEMENT ON SUBURBAN WATERSHEDS

Washington Univ., Seattle, WA, Coll. of Engineering. B. Glenne. Water Resources Bulletin, Vol. 20, No. 2, p. 211-217, April, 1984. 2 Fig., 4 Tab, 12 Ref.

Descriptors: *Watershed management, *Simulation, *Water pollution sources, *Salt Lake City, *Utah, Coliforms, Bacteria, Suspended solids, Water quality control, Assimilative capacity, Computers.

Computer simulation and model calibration of three suburban watersheds near Salt Lake City, Utah, indicate that coliform bacteria and suspended solids are produced mainly by the presence of people, domestic animals, vehicles, disposal systems, and other constructed facilities. The importance of each of these activities is investigated and pollution abatement procedures are outline for purposes of improved watershed management. Water quality simulation for a watershed integrates several quite approximate methods in hydrology, environmental engineering, and urban planning. Numerical results should be regarded in this light. Of primary interest, is the focus provided by the technique on existing cause and effect pollution relationships in the given watershed. In particular, the simulation technique lends itself to mapping of pollution sources and identification of activities which generate stream pollution. By modifying the existing situations in the model the effects of proposed development or suggested abatement procedural may be roughly anticipated. The technique can also be used to estimate assimilative capacities of watersheds and streams. (Baker-IVI)
W84-05160

SOURCES AND FATES OF AROMATIC COMPOUNDS IN URBAN STORM-WATER RUNOFF

Mackenzie, M.J. (EPA); Hunter, J.V. (EPA; Rutgers Univ.). Environmental Science and Technology; 13: No. 2, p. 179-183 (Feb 1979).

Petroleum-derived aromatic hydrocarbons and associated sulfur compounds in urban storm-water runoff and Delaware River sediment samples were characterized with a gas chromatograph equipped with a flame ionization/sulfur specific flame photometric detection system. Total petroleum hydrocarbon concentrations were determined gravimetrically in storm water emanating from a northern Philadelphia storm sewer. Comparison of hydrocarbon and sulfur fingerprints of the aromatic fractions of environmental samples with reference oils indicated that crankcase oil was the most likely source of aromatics in storm-water runoff. A weathering study on used crankcase oils showed a loss of diaromatics which accounted for their absence in the environmental samples. Since aromatic sulfur compounds were preferentially associated with particulate matter in urban runoff, a mechanism was proposed in which fuel oils and lubricating oils released to the environment are adsorbed onto particulate matter. The lower boiling diaromatics are lost through natural weathering, and during a storm, the particulates are washed into sewers and then into receiving waters.

STORMWATER POLLUTION CONTROL: STRUCTURAL MEASURES

Santa Clara Univ., CA. Dept. of Civil Engineering. E. J. Finnemore. Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 108, No. EE4, p. 706-721, August, 1982. 6 Fig., 3 Tab, 11 Ref.

Descriptors: *Storm wastewater, *Combined sewer overflows, *Sewer systems, Water quality control, Overflows, Water pollution control, Seattle, Washington, Saginaw, Michigan, Mount Clemens, Wastewater treatment, Storm sewers, Cost-benefit analysis, Water storage, Control systems.

A review of information of costs, feasibilities and efficiences of combined sewer overflow (CSO) control measures reveals that no one method can handle all CSO problems. The most important feature of cost-effective structural control measures is storage. It attenuates peak flows, reduces overflows, and contains pollutants. Integration between storage and treatment is particularly effective because it can use the existing collection system, can use the most cost-effective combination of storage and treatment, and can integrate CSO controls with other facilities and projects to achieve higher levels of pollution control. Three case studies

of CSO control programs and described. Seattle, Washington, uses computerized in-line storage in existing sewer interceptors and trunk sewers. Saginaw, Michigan, integrates off-line storage/treatment with in-line storage and dry weather treatment to attain high performance at moderate costs. At Mount Clements, Michigan, the control program includes partial sewer separation, interception of overflows, and combined sewer storage and treatment facilities associated with a multiuse park and lake system for final polishing. Selecting an appropriate CSO control for a given site should consider reduction of total overflow volume, reduction of frequency of overlow events, and reduction of pollutant loadings to receiving waters. Tables comparing cost and performance for the three systems are given as a planning aid. Selection should also consider size, complexity, and ways to combine components and integrate them with other facilities. (Cassar-FRC)
W83-01944

TECHNOLOGY TRANSFER PROGRAM-URBAN STORMWATER MANAGEMENT IMPLEMENT IN IOWA

Iowa State Univ., Ames, IA, Dept. of Civil Engineering. R. L. Rossmiller.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-246454, Price codes: A05 in paper copy, A01 in microfiche. Iowa State Water Resources Research Institute Completion Report No 132, March 1983. 100 p., 7 Fig., 2 Tab, 9 Ref. OWRT A-082-IA(1), 14-34-0001-2117.

Descriptors: *Detention reservoirs, *Hydraulic design, *Hydrographs, *Land use, *Planning, *Urban hydrology, Culverts, Design floods, Legal aspects, Model studies, Multipurpose reservoirs, Storm sewers, *Storm water, Watersheds, *Iowa, Outlet structures, Watershed planning.

The objective of the recently completed Iowa Urban Stormwater Management Program was to make stormwater management an integral part of the activities of planners, engineers and politicians in existing urban areas and in new developments around metropolitan areas. Included in this overall objective were the legal institutional, planning, and technical aspects of stormwater management. Two concurrent studies were undertaken at the University of Iowa and at Iowa State University. The studies at the University of Iowa Law College concentrated on the legal and institutional aspects of urban stormwater management: how it is being implemented around the United States, what is possible under existing Iowa law, the development of model ordinances, and various methodologies for funding the construction and maintenance of stormwater facilities. The studies at Iowa State University concentrated on the planning and technical aspects of urban stormwater management: planning on both a watershed and an individual development basis, the use of both structural and nonstructural measures, and the effectiveness of on-site and offsite engineered facilities for both the primary and major systems. Emphasis was placed on the design of storm sewer systems and on the design of stormwater detention basins: various methodologies for the development of inflow hydrographs, the physical characteristics of basins for the development of stage-volume curves, and the hydraulics of several types of outlet structures for the development of stage-outflow curves. The results of these studies are contained in a planning and design manual.
W83-03696

THE CONTRIBUTION OF URBAN RUNOFF TO HYDROCARBON POLLUTION

Hunter, J. V. (Rutgers Univ.); Mackenzie, M. J.; Sabatino, T; Gomperts, R. *Journal — Water Pollution Control Federation*; 51: No. 8, p. 2129-2138 (Aug 1979).

The contribution of urban runoff to hydrocarbon pollution was studied by sampling a storm sewer in northern Philadelphia which discharges into Sandy Run, a tributary of the Delaware River. Five storm events were studied during the period 9/3/74-11/21/75. The runoff contained an average 3.69 mg/l. total hydrocarbons, which indicates a loading of 22.9 lb/yr/acre from urban areas on the lower Delaware Estuary. Of the total hydrocarbons, 69.6% were aliphatic and 30.4% aromatic. In addition, 86.4% were associated with the particulate materials present and only 13.6% with the soluble constituents. However, as the runoff increased, the fraction of hydrocarbons associated with the particulates also increased. No relationship was found between load and the time since prior rainfall, but a relationship was found between runoff and load. Preliminary analysis showed the primary source of these hydrocarbons may be crankcase oil.

TWO-STAGE URBAN RUNOFF FORECAST MODEL

McMaster Univ., Hamilton (Ontario). Dept. of Civil Engineering and Engineering Mechanics. G. G. Patry and M. A. Marino.
Journal of Water Resources Planning and Management, Vol. 110, No. 4, p. 479-496, October, 1984. 4 Fig., 6 Tab, 28 Ref., 1 Append. CSRS project CA-D*-LAW-4254-H.

Descriptors: *Urban runoff, *Storm runoff, *Runoff forecasting, *Computer models, Combined sewer overflows, Storm wastewater, Water pollution control, Automation.

Storm-related pollution in general, and combined sewer overflows in particular, have been found to contribute significant amounts of pollutants to receiving water bodies. Control of pollution from these nonpoint sources of pollution is very costly. Accordingly, integrated real-time control of combined sewer overflow is being considered as a possible alternative to the more traditional forms of pollution control. The basic features of suggested control combined sewer overflow control strategies are reviewed, including simple local control, reactive control, and anticipatory control. Because water quantity forecasts are essential to any integrated real-time control strategy, the

application of a simple microcomputer-based two-stage urban runoff forecast model is examined. Runoff forecasts from this deterministic-stochastic model are provided for lead times ranging from 1-12 time steps (5-60 min). The two-stage approach is found to be particularly useful for lead times of up to 30 min. (Author's abstract)
W85-03065

URBAN PLANNING CIRTERIA FOR NON-POINT SOURCE WATER POLLUTION CONTROL

Catholic Univ. of American, Washington, D.C. Dept. of Civil Engineering. G. K. Young and D. L. Danner. Available from the National Technical Information Service, Springfield, VA 22161 as PB83-182261, Price codes: A09 in paper copy, A01 in microfiche. D.C. Water Resources Research Center Report No. 35, Univ. of the District of Columbia, March 1982. 163 p., 21 Fig., 14 Tab, 45 Ref, 2 Append. OWRT A-009-DC(1), 14-34-001-1109

Descriptors: *Water pollution, *Urban hydrology, *Water quality modeling, Planning criteria, In-line storage, Stormwater detention, Sewer separation, Street sweeping, Sewer flushing, Wastewater treatment, Best management practices, *Nonpoint pollution sources.

The research described in this document couples urban storm runoff quality and control alternatives within the context of an urban sewerage system to evaluate various combinations of alternatives through their pollution removal efficiencies and their costs. A model has been developed which simulates the response of a typical urban area to a time series of rainfall events, and which uses the District of Columbia as an example. The modeling of the flow of runoff and sewage has been performed at a macro level; the control alternatives examined include in-line storage, sewer separation, street sweeping, sewer flushing, stormwater detention, and increased treatment capacity. Each pollution abatement measure is described with a pollution function, a pollution removal function, and a cost function. The simulation model with its associated decision criterion was validated against actual water quality data for Washington, D.C. The model demonstrates that a macro approach to cost/benefit analysis of non-point source water pollution can evaluate control tradeoffs in terms of cost or in terms of abatement effectiveness. The importance of the developed methodology is that it provides an accurate estimate of urban pollution loads, pollution control capabilities, and control without requiring complex graphical techniques or large, explicit simulations. The user is not required to supply any technical or specialized information to run the model; the only inputs to the model are readily available physical characteristics of the urban area.
W83-02317

URBAN RUNOFF AS A SOURCE OF POLYCYCLIC AROMATIC HYDROCARBONS TO COASTAL WATERS

Hoffman, E. J.; Mills, G. L.; Latimer, J.S.; Quinn, J. G. (Univ. of Rhode Island, Narragansett). Environmental Science and Technology; 18: No. 8, p. 580-587 (Aug. 1984).

Urban runoff samples collected from four storm drains, each serving a different land use, were analyzed for selected polycyclic aromatic hydrocarbons (PAHs) by gas chromatography. The PAH concentrations varied widely during the history of each storm and appeared to be most concentrated in first or second flushes. Higher molecular weight PAHs were mostly found associated with the particulates and were enriched on two different particle sizes, a small particle fraction and a larger particle fraction, perhaps from different sources. The annual input of PAHs to the upper Narragansett Bay watershed was calculated by using storm loads with local rainfall and land use data. The loads of PAHs [mass (drainage area)$^{-1}$ year^{-1}] in urban runoff were higher at the highway and industrial land uses in comparison to the commercial and residential area. Urban runoff PAHs are similar in composition to that found in atmospheric fallout but unlike the PAHs in municipal effluents. Comparison of urban runoff PAH inputs to other sources entering Narragansett Bay showed that urban runoff accounted for 71% of the total inputs for higher molecular weight PAHs and 36% of the total PAHs.

URBAN RUNOFF AS A SOURCE OF POLYCYCLIC, AROMATIC HYDROCARBONS TO COASTAL WATERS

E. J. Hoffman, G. L. Mills, J. S. Latimer, and J. G. Quinn. Environmental Science and Technology, Vol. 18, No. 8, p. 580-587, August, 1984. 2 Fig., 6 Tab, 31 Ref. NOAA grant NABORAD00047.

Descriptors: *Urban runoff, *Polycyclic aromatic hydrocarbons, *Water pollution sources, *Narragansett Bay, Coastal waters, Land use, Aromatic compounds, Hydrocarbons, Particulates, Rainfall, Storm runoff, Highways, Industrial areas, Residential areas.

Urban runoff samples collected from four storm drains, each serving a different land use, were analyzed for selected polycyclic aromatic hydrocarbons (PAHs) by gas chromatography. The PAH concentrations varied widely during the history of each storm and appeared to be most concentrated in first or second flushes. High molecular weight PAHs were mostly found associated with the particulates and were enriched on two different particle sizes, a small particle fraction and a larger particle fraction, perhaps from different sources. The annual input of PAHs to the upper Narragansett Bay watershed was calculated by using storm loads with local rainfall and land use data. The loads of PAHs (mass/(drainage area)/year) in urban runoff were higher at the highway and industrial land uses in comparison to the commercial and residential areas. Urban runoff PAHs are similar in composition to that found in atmospheric fallout but unlike the PAHs in municipal effluents. Comparison of urban runoff accounted for 71% of the total inputs for higher molecular weight PAHs and

36% of the total PAHs. (Author's abstract)
W85-02108

URBAN RUNOFF CONTROL TECHNOLOGY

Ontario Ministry of the Environment, Toronto. G. Zukovs, D. G. Weatherbe, and J. Marsalek. Civil Engineering (New York), Vol. 52, No. 8, p. 50-52, August, 1982. 3 Fig., 1 Tab.

Descriptors: *Urban runoff, *Storm water, *Flow control, Runoff, Controlled drainage, Wastewater treatment, Inlets, Underground storage, Water storage, Storm sewers, *Ontario, Controlled storage, Storage, Bacteria, Drainage, Ponds, Storm runoff, Storm wastewater, Coliforms.

A variety of controls for urban runoff quantity and quality has been used in the Ontario region. These include inlet controls to restrict flow to sewers during high, intense precipitation or to permit overland drainage where feasible and underground storage or pond storage in parks and other locations. Studies on storm water treatment of pollutants revealed that 10 hours of quiescent settling or alum flocculation with 2 hours quiescent settling were effective in removing pollutants. Bacterial levels were not significantly reduced by natural settling, but dosage of 5 mg per liter available Cl reduced fecal coliforms to less than 10 per 100 ml. (Cassar-FRC).
W83-00416

URBAN STORMWATER MANAGEMENT NEEDS IN NORTH CAROLINA

North Carolina State Univ. at Raleigh, NC, Dept. of Civil Engineering. H. R. Malcolm and J. M. Sappington. Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113687, Price codes: A06 in paper copy, A01 in microfiche Water Resources Research Institute Report No. 199, August 1983. 111 p., 10 Fig., 11 Tab, 36 Ref, 2 Append. OWRT B-116-NC(1), 14-34-0001-9125.

Descriptors: *Storm runoff, *Institutional constraints, Stream degradation, Stream erosion, *Urban watersheds, *North Carolina, *Stormwater management, Water quality.

Current practices in stormwater management were examined to provide recommendations for improvement, particularly in the areas of institutional arrangements and technical support. Because of fragmented institutional arrangements and site-specific conventions of design, the network of urban streams suffers from lack of comprehensive treatment of problems of flooding, sedimentation and inferior water quality. If public perception of the value of a better-performing urban stream system is sufficiently well formed to support systematic improvement, the approach recommended is to reform the current fragmented system into a storm-water public utility in parallel to those of water, sewer and street systems. Set at the local level, the public-utility approach would provide for the needed comprehensive planning, design and management. The principal analytical resource needed is that of watershed modeling to simulate urbanizing watersheds adequately for making the planning and design decisions respecting the interactions of system components. A micro-computer program was prepared which uses impulse analysis for the study of streambank behavior under the influence of varying hydrograph shapes. The program, user instructions and case studies are given. An annotated bibliography of reference materials on project topics is included.
W84-00166

WATER QUALITY OF AIRPORT STORM RUNOFF PHASE II

Hawaii Univ. at Manos, Honolulu. Water Resources Research Center. G. L. Dugan. Available from the National Technical Information Service, Springfield, VA 22161 as PB83-246439, Price codes: A03 in paper copy, A01 in microfiche. Technical Report No 153, May 1983. 44 p., 6 Fig., 4 Tab, 14 Ref., 2 Append. OWRT A-086-H1(1), 14-34-0001-1113.

Descriptors: *Storm runoff, *Water supply, *Water quality standards, Water sampling, Pollutant identification, Nonpoint pollution source, Heavy metals, *Airports, Honolulu International Airport, General Lyman Field, Kahului Airport, Keahole Airport, Lihue Airport, *Hawaii.

The quality of natural and induced storm water runoff from several smaller public airports in Hawaii (air traffic volume of approximately 130 to over 350 airplanes/day) was compared to results from the previous Phase I study of the Honolulu International Airport that handles daily nearly 900 airplanes. The mean annual rainfall of these airports ranges from approximately 381 mm (15 in.) to nearly 3 251 mm (128 in.). Two basic storm quality monitoring schemes were incorporated: the wet season and the dry season. The wet-season monitoring involved collecting storm runoff samples from paved surfaces during the following rainfall events at a specific airport. The dry-season monitoring scheme consisted of enclosing a 0.25-m super 2 (2.69-ft super 2) area, applying deionized water, and then collecting the wash water, leached chemicals, and sediments by a hand bilge pump. As was the case for the storm runoff quality from the previous study of the Honolulu International Airport, the runoff from the smaller airports also contained mercury and turbidity that significantly exceeded the primary drinking water regulations, while concentrations of phenol and carbon chloroform extract definitely indicated that petroleum-derived products would be too high (expensive to remove) for consideration as an alternate drinking water supply. However, the water, if collected and stored could serve as a source of subpotable water.
W83-03688

WATER QUALITY OF AIRPORT STORM RUNOFF

Hawaii Univ. at Manos, Honolulu. Water Resources Research Center. E. Christakos-Comack and G. L. Dugan.

Available from the National Technical Information Service, Springfield, VA 22161 as PB83-224170, Price codes: A03 in paper copy, A01 in microfiche. Technical Report No.144, July 1982. 30 p., 5 Fig., 7 Tab, 22 Ref. OWRT A-086-HI(1), 14-34-0001-1113.

Descriptors: *Storm runoff, *Water supply, *Water quality standards, Water sampling, Pollutant identification, Heavy metals, *Hawaii, *Honolulu International Airport, *Nonpoint pollution sources.

The quality of natural and induced storm runoff was ascertained from the 11.33 x 10 super 6 m super 2 (2800 acre) Honolulu International Airport (daily average air traffic volume of about 1000 planes and a mean annual rainfall of approximately 508 mm (20 in.) by incorporating two monitoring schemes, the wet season and the dry season. The wet-season monitoring involved collecting storm runoff samples during the following rainfall events at established airport sites on paved surfaces. The dry-season monitoring scheme consisted of enclosing a 1.0-m super 2 (10.8-ft super 2) area, applying deionized water, and then collecting the wash water, leached chemicals, and sediments by a heavy-duty vacuum cleaner. Phenol, mercury, and turbidity exceeded the primary drinking water regulations, while pH, manganese, and total dissolved solids at times exceeded secondary drinking water regulations. Grease and oil concentrations showed a definite decrease from the Terminal Building (service and fueling area) to the outer drainage sites. High technology treatment, costing nearly four times the present cost of municipal water, would be required to meet potable water requirements; however, for subpotable use, an equalization basin could be constructed for one-half the cost of municipal water. The 1985 projected water demand volume could be met by recovered storm runoff. W83-03353

AGRICULTURAL AND WATER QUALITY IN THE CANADIAN GREAT LAKES BASIN: IV NITROGEN

Department of Agriculture, Summerland (British Columbia). Research Station. G.H. Neilsen, J.L.B. Culley, and D.R. Cameron.
Journal of Environmental Quality, Vol 11, No 3, p. 494-497, 1982. 1 Fig., 4 Tab, 25 Ref. Descriptors: *Agricultural watersheds, *Great Lakes, *Nitrogen, *Ontario, Watersheds, Pollution load, Water pollution sources, Nonpoint pollution sources, Fate of pollutants, Animal wastes, Farm wastes, Water quality control, Streams, Nitrates, Farm management, Clays, Agricultural runoff, Runoff, Fertilizers, Seasonal variation, Livestock.

Total Kjeldahl N and nitrate-N were sampled in stream runoff in 11 agricultural watersheds in southern Ontario during 1975-76. Of the 3000 samples, nitrate levels exceeded the 10 mg per liter drinking water standard in 3%. About half of the high concentrations occurred June and July storms and were associated with intense agricultural land use. Average annual total nitrogen stream loads were 3.5 to 29.2 kg N per watershed ha for the years 1975 and 1976. Nitrate accounted for an average of 75% of the total stream N loads. Both nitrate and total N loads were significantly correlated with addition of N to the watershed and with % of watershed under cultivation, in row crops and corn, or tile drained. Total N was also correlated with surface soil clay content and with extent of soils with high surface runoff potential. It was recommended that stream N loading be reduced in watersheds where loading greatly exceeds inputs of N from precipitation. In these watersheds the greatest potential for reducing N loads is improved fertilizer efficiency in corn production. Although manure storage areas and feedlots did not contribute greatly to total N loads, proper waste management methods are important. 71% of the nitrate-N and total N loading occurred in January-April. (Cassar-FRC)
W83-03988

AGRICULTURAL IRRIGATION TECHNOLOGY TRANSFER ASSESSMENT

Pennsylvania State Univ., University Park. Inst. for Research on Land and Water Resources. C.A. Marro, E.M. Roe, and W.E.Sharpe.
Available from the National Technical Information Service, Springifled, VA 22161 as PB83-219956, Price codes: A04 in paper copy, A01 in microfiche. Complete Report, February 1982. 49 p., 5 Append. OWRT C-00192-T (No. 0496(2), 14-34-0001-0496.

Descriptors: *Technology transfer, *Agricultural irrigation, *Irrigation efficiency. *Technology transfer products, *User needs assessment, Products strengths, Product weaknesses, Users identified, Western U.S., Southeastern U.S.

The assessment of agricultural irrigation technology transfer begins with a short history of irrigation and a discussion of problems caused by inefficient irrigation methods. A description of the search strategy-which included a literature search, consultation with computerized information files, contact with irrigation experts and government agencies-follows. Groups and individuals who may use agricultural irrigation technology are identified and characterized by number and geographical distribution. User needs, such as technical level of information or publication format, are discussed. Significant research and technology transfer products, along with strengths and weaknesses are included. The Federal or State agencies, associations or corporations which produced the products are listed. A section is devoted specifically to technology transfer produced in the Southeast because many products and programs have been produced in the region. The need for efficient irrigation water use in the southeast is not as serious as it is in the western states. Therefore, this section is the only part of the assessment which discusses the eastern U.S. Recommendations are made for five technology products and programs. Format, topic outlines, and cost-benefit analyses are included where appropriate. Supplemental appendix sections listed interested government agencies, names and addresses of contacts, journals, associations, and technology transfer products.
W83-03281

AGRICULTURAL RUNOFF AS A NONPOINT EXTERNALITY: A THEORETICAL DEVELOPMENT

Texas A and M Univ., College Station, TX, Dept. of Agricultural Economics, R.C. Griffin and D.W. Bromley.
American Journal of Agricultural Economics, Vol. 64, No. 3, p. 547-552, August, 1982. 1 Tab, 6 Ref.

Descriptors: *Nonpoint pollution sources, *Environmental policy, *Agricultural runoff, *Agricultural watersheds, *Economic aspects, Runoff, Public policy, Legal aspects, Water pollution control, Mathematical models, Environmental protection.

A theory dealing with agricultural runoff as a nonpoint externality was developed and explored. Nonpoint production functions can be relied upon to estimate the amount of pollution in the runoff of individual farms from their production activities. Economically efficient policies based on regulations and/or incentives can be designed based on the factors which actually determine pollution levels. Optimal parameters can be mathematically specified. A simple static model of the traditional point-source externality was used to evaluate four runoff policies. (Small-FRC)
W83-00747

AGRICULTURAL STREAM ECOSYSTEMS: STRUCTURE AND FUNCTION FOR UNDERSTANDING WATER QUALITY IMPROVEMENTS

Iowa State Unit., Ames. Dept. of Animal Ecology, J.B. Barnum and R.W. Bachmann.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-224261, Price codes:

A06 in paper copy, A01 in microfiche. Iowa State Water Resources Research Institute Publication No. 124, March 1983. 113 p., 22 Fig., 37 Tab, 49 Ref. OWRT A-079-IA(1), 14-34-00-0017.

Descriptors: *Agricultural watersheds, *Decomposition, *Primary production, Water quality, *Invertebrates, Streams, Riparian, Vegetation, *Land use, Impacts, Phosphorus, Chlorophyll a, Suspended solids, Nitrogen.

Twelve emphemeral to perennial stream sites within eight agricultural watersheds were studied in order to define key ecological processes regarding in-stream functional adjustments to agricultural watershed impacts. The ecological processes or indices investigated were detrital decomposition, primary production, invertebrate community structure, water quality and analyses of watershed land use practices. The drainages were differentially impacted by intensive row crop development, grazing, removal of riparian vegetation, channelization and drainage tiling. All sites displayed impaired water quality (e.g. high nutrient and suspended solid concentrations), although tree-shaded sites displayed cooler summertime temperatures and significantly faster decomposition rates then open canopy sites. Decomposition dynamics were associated with invertebrate shredder communities. Open sites transported higher suspended chlorophyll a concentrations, displayed greater attached algal biomass, exhibited wider diurnal oxygen fluxes, and were dominated by collector-scraper invertebrate assemblages compared to tree-shaded sites. Agricultural streams were compared with other less impacted drainages, traditional stream concepts were explored, and a conceptual agricultural stream model was proposed. This study identifies land use practices qualitatively implicated in impairing stream water quality. However, large scale watershed manipulation experiments will be necessary in order to quantitatively predict the effects of agricultural land use practices on stream water quality.
W83-03377

AGRICULTURE AND WATER QUALITY IN THE CANADIAN GREAT LAKES BASIN: I. REPRESENTATIVE AGRICULTURAL WATERSHEDS

Department of Agriculture, Ottawa (Ontario), Land Resource Research Inst. D.R. Coote, E.M. MacDonald, W.T. Dickinson, R.C. Ostry, and R. Frank.

Journal of Environmental Quality, Vol. 11, No. 3, p. 473-481, 1982. 1 Fig., 8 Tab, 16 Ref.

Descriptors: *Agricultural watersheds, *Great Lakes, *Ontario, Monitoring, Water quality, Pollution loads, Fate of Pollutants, Water pollution sources, Nonpoint pollution sources, Watersheds, Clays, Streams, Agricultural runoff, Runoff, Erosion, Fertilizers, Tile drainage, Livestock, Animal wastes, Farm wastes, Farm management, Land use.

Eleven representative agricultural watersheds in the southern Great Lakes drainage basin were chosen for monitoring as part of the PLUARG study on pollution loads. The regions were separated according to an index measuring the soil's potential to transfer pollutants to surface and groundwater. This index was strongly correlated with soil clay content. Study regions were 1,990 to 7,913 ha in area, 22 to 89% cultivated, 0 to 99% tile drained, 10 to 66% row-cropped, and stocked with up to 0.77 units of livestock per ha. During January-April 32% of the annual precipitation and 65% of the stream discharge were measured. Erosion potential was significantly positively correlated with row crops, fertilizer N, and tile drainage density. (Cassar-FRC)
W83-03983

AGRICULTURE AND WATER QUALITY IN THE CANADIAN GREAT LAKES BASIN: II, FLUVIAL SEDIMENTS

Department of Agriculture, Guelph (Ontario), Inst. of Pedology. G.J. Wall, W.T. Dickinson, and L.J.P. Van Vliet.

Journal of Environmental Quality, Vol. 11, No. 3, p. 482-486, 1982. 2 Fig., 5 Tab, 19 Ref.

Descriptors: *Agricultural watersheds, *Great Lakes, *Suspended sediments, *Ontario, Sediments, Erosion, Fate of pollutants, Water pollution sources, Nonpoint pollution sources, Agricultural runoff, Runoff, Watersheds, Water quality, Streams, Farm management, Pollution load.

A study of 11 small agricultural watersheds in southern Ontario showed that unit area yields of suspended sediments ranged from < 100 to 1000 kg per ha per year during 1976-76. Bank erosion contributed an estimated 0 to 30% of the suspended sediment; cropland sheet and rill erosion, 70-100%. Regression analysis of 14 watershed characteristics vs. unit area yields showed that % clay of the surface soil and % row crop were the most significant factors in estimating suspended sediment yields. Three methods for predicting suspended sediment yields were compared: P a regression equation developed from the watershed studies, extrapolation of measured unit are yields obtained from the agricultural watersheds to similar areas in the Grand and Saugeen basins, and the Universal Soil Loss Equation plus a delivery ratio. The third method proved unsuitable for the Canadian climate. Suspended sediment yield from agricultural land in each of 300 subwatersheds in the lower Canadian Great Lakes Basin was determined by extrapolation. Estimated suspended sediment yield from agricultural land in the southern Ontario portion of the Great Lakes basin was 652,872 tons per year: almost 300,000 tons per year each into Lakes Huron and Erie, the remainder into Lake Ontario and Georgian Bay. (Cassar-FRC).
W83-03987

AGRICULTURE AND WATER QUALITY IN THE CANADIAN GREAT LAKES BASIN: V. PESTICIDE USE IN II AGRICULTURAL WATERSHEDS AND PRESENCE IN STREAM WATER, 1975-1977

Ontario Ministry of Agriculture and Food, Guelph. Pesticide Residue Lab. R. Frank, H.E. Braun, M.V.H. Holdrinet, G.J. Sirons, and B.D. Ripley.

Journal of Environmental Quality, Vol. 11, No. 3, p. 497-505, 1982. 13 Tab, 35 Ref.

Descriptors: *Pesticides, *Agricultural watersheds, *Great Lakes, *Ontario, Insecticides, Herbicides, Fungicides, Nematocides, Fate of pollutants, Atrazine, Water quality, Streams, Watersheds, Pollution load, Agricultural runoff, Runoff, Water pollution sources, Nonpoint pollution sources.

A survey of pesticide use in 11 agricultural watersheds in sourthern Ontario showed that 81 pesticides were applied during 1975 on 39% of the land surface at a rate of 8.27 kg per ha per year. This was equivalent to 3.25 kg per ha per year over the whole area. Analysis of stream water samples from the 11 watersheds revealed 41 pesticides that were on the list of materials applied. Drainage waters contained 18 parent compounds, 3 matabolites, and 1 industrial organic pollutant. DDT, TDE, an HEOD were identified in water samples although they have not been used for several years. Several pesticides (atrazine, endosulfan, and simazine) were persistent enough to appear in water samples throughout the year. The overall unit area loading to streams by pesticides was 2.18g per ha per year, of which atrazine accounted for 2.01 g per ha per year. Pesticides entered the stream water from storm runoff waters (60%), in base flow from internal soil drainage (18%), and from spills adjacent to streams (22%). Those chemicals whose levels exceeded the International Joint Commission water quality standards were polychlorobiphenyls (78% of samples), total DDT (41% of samples), HEOD (16% of samples), endosulfan (14% of samples), and heptachlor epoxide (14% of samples). (Cassar-FRC)
W83-03982

ANIMAL FEEDLOT RUNOFF IN THE PIEDMONT

Clemson Univ., SC. Dept. of Agricultural Engineering, R.O. Hegg, C.L. Barth, and W.H. Hanvey.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-248393, price codes: A03 in paper copy, A01 in microfiche. Water Resources Research Institute Report No. 109, July 1983. 28 p., 4 Fig., 4 Tab, 20 Ref, 3 Append. OWRT B-126-SC(1), 14-34-0001-9133.

Descriptors: *Surface runoff, Runoff volume, *Feedlot runoff, Animal wastes, Rainfall intensity, *Erosion, Runoff, *Rainfall-runoff relationships, Settling basins, *South Carolina, Piedmont region.

Animal feedlots are characterized by compacted soils and a lack of vegetation. In the South Carolina Piedmont Region high annual rainfalls (55 in/yr) on the animal feedlots can cause polluted water to enter streams and flakes. This three year study was conducted at a 10.19 acre feedlot at the Clemson University Simpson Experiment Station. A sampling station was constructed to measure the Mine Drainage, Mine wastes, Mineralogy, Strip mine wastes, Sulfur compounds, *West Virginia.

Control or prevention of the drainage of acid mine water into streams is perhaps the greatest water problem in West Virginia and in the coal-mining areas of the region. After many years and much effect, the basic characteristics of the material generally accepted as pyrite, that yields the acid are still not adequately understood. Planning, management, and control of this toxic pollutant are hindered without a sufficient understanding of the mechanisms of acid formation. This project was a small part of a continuing research effort of the principal investigator to gain a sufficient understanding of the mechanisms of mine-acid formation. A single 24-hour leaching of acid-producing materials yields an acid load of the same relative magnitude as extended leaching-reoxidation cycles. The best parameter for estimating acid yield is total-rock iron, followed by total-rock sulfur. For greater than half an inch, particle size appears not to influence the rate of acid yield; below that, yield increases exponentially decreasing size. The most reactive morphological form of pyrite is the massive variety; not the framboidal.
W83-03820

ATRAZINE AND SIMAZINE MOVEMENT TO WYE RIVER ESTUARY

Agricultural Research Service, Beltsville, MD, Soil Nitrogen and Environmental Chemistry Lab. D.E. Glotfelty, A.W. Taylor, A.R. Isensee, J. Jersey, and S. Glenn.
Journal of Environmental Quality, Vol. 13, No. 1, p. 115-121, 1984. 5 Fig., 3 Tab, 29 Ref.

Descriptors: *Atrazine, *Simazine, *Wye River, *Estuaries, Runoff, Agricultural runoff, Agricultural watersheds, Herbicides, Water pollution sources, Fate of pollutants, Chesapeake Bay.

The Wye River, a tributary of Chesapeake Bay, is a shallow, well-mixed estuary surrounded by an agricultural watershed, a large portion of which is planted in corn (Zea mays L.). A 3-year study of the movement of atrazine (2-chloro-4-ethylamino-6-isoproplylamino-s-triazine) and simazine (2-chloro-4,6-bis(ethylamino)-s-triazine) showed that the total amount of herbicide reaching the estuary depended upon the quality applied in the watershed and the timing of runoff with respect to application dates. In a year in which significant runoff occurred within 2 weeks of application, 2 to 3% of the atrazine moved to the estuary. In other years with less runoff, or runoff delayed longer after application, much smaller quantities reached the estuary. Simazine loading was one-tenth that of atrazine. Once in the estuary, atrazine and simazine remained in solution, diluted in a conservative manner with estuarine water, and dissipated with a 10- to 30- d half-life. The maximum measured concentration of atrazine was near 15 microg/L but average concentration at peak loading was < 3 microg/L. Thus, although the Wye River has a high percentage of watershed land planted to corn, herbicide concentrations rarely approached those producing minor effects on submerged aquatic vegetation. (Author's abstract)
W84-03943

BUMPER CROP YIELDS GROWING PROBLEMS

SAI Comsystems Corp., Eureka, CA, L. McWilliams. Environment, Vol. 26, No. 4, p. 25-33, May 1984. 5 Fig., 2 Tab, 21 Ref.

Descriptors: *Groundwater pollution, *Nitrates, *Agricultural chemicals, *Wisconsin, Aldicarb, Legislation, Water management, Insecticides, Fertilizers, Leaching, Soil properties.

While agricultural chemicals have helped to set new crop production standards, they sometimes have combined to pollute groundwater and endanger the health of people, livestock, and other animals. Wisconsin's Central Sands region is an example of an area that has reaped the rewards of modern agricultural practices at the expense of water quality. The Central Sand's susceptibility to groundwater pollution began thousands of years ago when glaciers retreated northward, depositing sandy, loamy soils in thin layers on top of igneous and metamorphic bedrock. The adverse environmental and economic consequences of overirrigation or excessive precipitation on sandy soils is known. One problem is the presence of insecticides and other agricultural chemicals in the groundwater. News of aldicarb in Wisconsin groundwater came too late for action during the 1981 growing season. Subsequent changes can make such an occurrence less likely in the future. The outlook for nitrates is not as good. Nonpoint source pollution is ubiquitous. There are three avenues toward the goal of groundwater free of pollution: federal, state, and local or citizen action. Federal action could include legislation protecting groundwater, incentives to states that voluntarily implement groundwater management, or programs that would aid innovative farmers in implementing practices that prevent groundwater pollution. At the local level, even if laws are passed, it will take time to get meaningful enforcement. The forcefulness of national environmental and conservation groups cannot be ruled out in this issue of great concern. (Baker-IVI)
W85-00277

CATTLE GRAZING IMPACT ON SURFACE WATER QUALITY IN A COLORADO FRONT RANGE STREAM

Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO, H.L. Gary, S.R. Johnson, and S.L. Ponce.
Journal of Soil and Water Conservation, p. 124-128, March-April, 1983. 3 Fig., 3 Tab, 23 Ref.

Descriptors: *Surface water, *Water pollution sources, *Grazing, *Cattle, *Colorado, Suspended solids, Ammonia, Bacteria, Eutrophication, Manure, Water quality.

Cattle grazing in pastures bisected by a small perennial stream in central Colorado had only minor effects on water quality during two years of study. Suspended solids and nitrate nitrogen did not increase significantly. The ammonia nitrogen increased significantly only once under moderate rates of grazing. Indicator bacteria densities in the stream water were significantly higher when at least 150 cattle were grazing. After removal of cattle or when 40 head of cattle were grazing, bacterial counts dropped to levels similar to those in an adjacent, ungrazed pasture. About 5% of the total manure produced by cattle contributed to pollution and/or enrichment of the stream. (Murphy-IVI)
W84-03057

CHEMICAL WATER QUALITY OF RUNOFF FROM GRAZING LAND IN NEBRASKA: II CONTRIBUTING FACTORS

Agricultural Research Service, Lincoln, NE. J.S. Schepers, B.L. Hackes, and D.D. Francis.
Journal of Environmental Quality, Vol. II, No. 3, p. 355-359, 1982. 1 Fig., 5 Tab, 10 Ref.

Descriptors: *Grazing, *Farm wastes, *Nonpoint pollution sources, Farm management, Livestock, Pastures, *Nebraska, Precipitation, Runoff, Agricultural runoff, Water quality, Animal wastes, Manure, Vegetation, Wildlife, Nutrients, Organic matter, Nitrates, Phosphorus, Chlorides, Ammonium, Water pollution sources, Fate of pollutants, Pastures.

The effects of climatic factors, hydrologic factors, and management practices on the chemical quality of runoff from a 32.5 ha cow and calf pasture in Nebraska were studied in 1976-78. Precipitation and hydrologic characteristics, stocking rates, and sediment contents in the runoff were used to predict the average concentrations of ammonium-N, nitrate-N, Kjeldahl N, soluble P, total P, total organic carbon, COD, and chloride. Animal stocking density significantly influenced the predicted concentrations of ammonium-N, nitrate-N, total P, total organic carbon, and COD in the runoff. However, dilution was the dominant process. Likely sources of pollutants were standing plant material and manure. Chloride appeared to be an indicator of wildlife activity. (Cassar-FRC)
W83-03967

CHEMICAL WATER QUALITY OF RUNOFF FROM GRAZING LAND IN NEBRASKA: I. INFLUENCE OF GRAZING LIVESTOCK

Agricultural Research Service, Lincoln, NE. J.S. Schepers and D.D. Francis
Journal of Environmental Quality, Vol. 11, No. 3, p. 351-354, 1982. 3 Tab, 18 Ref.

Descriptors: *Grazing, *Farm wastes, *Nonpoint pollution sources, Pastures, *Nebraska, Runoff, Water quality, Farm management, Animal wastes, Manure, Vegetation, Wildlife, Nutrients, Organic matter, Nitrates, Phosphorus, Chlorides, Ammonium, Water pollution sources, Fate of pollutants, Livestock.

The quality of runoff water from a 32.5 ha cow and calf pasture in Nebraska was studied for three years, 1976-78. Three types of pastures were included: ungrazed pasture

(control), grazed pasture with livestock actively grazing, and grazed pasture with livestock absent. The runoff water from pasture with actively grazing livestock had higher concentrations of all water quality parameters with respect to the grazed pasture with no livestock present, with the exception of Kjeldahl N, which decreased by 19%. The increases were: total solids, 52%; total organic carbon, 11%; COD, 7%, ammonium-N, 6%, nitrate-N, 45%; total P, 37%; soluble P, 48% and chloride, 78%. Runoff from the control area was tea-colored and had the poorest quality, with 1.94 to 10.8 times greater concentrations of pollutants. This was attributed to wildlife activity and leaching of nutrients and organic matter from vegetation. (Cassar-FRC)
W83-03981

COMBINED WATER-FERTILIZER MANAGEMENT TO MINIMIZE NON-POINT WATER POLLUTION WHILE ACHIEVING HIGH CROP PRODUCTION

California Univ., Riverside, CA, Dept. of Soil and Environmental Sciences. J. Letey and W.M. Jarrell.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-196691, Price codes: A02 in paper copy, A01 in microfiche. California Water Resources Center Completion Report, Univ. of California, Davis, April 1983. 17 p., 12 Ref. OWRT B-203-CAL(1).

Descriptors: *Irrigation, *Fertilizers, *Nitrogen, Drip irrigation, Furrow irrigation, Sprinkler irrigation, Irrigation efficiency, Vegetable crops, *California, *Nonpoint pollution sources.

Greenhouse and field experiments were conducted to characterize relationships between fertilizer and water management in irrigated vegetable production in California. Greenhouse trials were conducted both in hydroponic solution culture and in soil culture, with tomatoes and lettuce, to establish functional relationships between nitrogen and water uptake by single plants, and nitrogen recovery efficiency as a function of method and rate of application and placement for simulated drip irrigation system with one fertilizer material, urea-ammonium nitrate. Over a wide range of solution culture nitrogen concentrations, the relationship between nitrogen absorbed and water absorbed by the plant was constant. Slightly more N was taken up by plants where the emitter was placed 2.5 cm below the soil surface; less than 0.1% of the supplied N was recovered in acid traps as volatilized ammonia. Field trials with drip-irrigated tomatoes and celery, furrow-irrigated broccoli, celery, and corn, and sprinkler-irrigated celery and broccoli established relationships between quantity of N applied, method of N application (soil-applied soluble or slow release fertilizers, midseason sidedressing, application through irrigation water), quantity of water applied, and crop yield and nitrogen accumulation. Application of fertilizer in the irrigation was most efficient where no runoff occurred, and where plants grew rapidly. When plants grew slowly due to intermittent drought stress, nitrogen recovery efficiency was lower than where adequate but not excessive quantities of water were applied. Application of fertilizer in the irrigation water must anticipate crop nutrient demand to be effective, and must be placed in the root zone. (Snyder-California)
W83-02907

COMPARISON OF RUNOFF QUALITY FROM CATTLE FEEDING ON WINTER PASTURES

Idaho Univ., Moscow, ID, J.E. Dixon, G.R. Stephenson, A.J. Lingg, D.V. Naylor, and D.D. Hinman.
Transactions of the American Society of Agricultural Engineers, Vol. 26, No. 4, p. 1146-1149, July-August, 1983. 5 Tab, 7 Ref.

Descriptors: *Pastures, *Cattle, *Hay, *Water pollution sources, Idaho, Irrigation-return flow, Alfalfa, Grasses, Water pollution control, Filter crops.

Most cow-calf ranchers in the rocky Mountain Region confine their cattle during the winter and graze them from late spring to early fall. During the grazing season, most of the confinement areas are irrigated and used to produce alfalfa or mixed species hay. The loss of ten chemical, two bacteriological, and four other constituents from cow-calf wintering areas in Owyhee County, Idaho was quantified. Three hay crops were examined for their potential to filter the pollutants from the holding area runoff. Three hay crops (ground cover) treatments with two replications were established using a mixture of alfalfa with one of three grasses: brome, fescue, and orchard grass. Cattle were placed on plots each winter and removed each spring for three years. The plots were irrigated twice each year. Irrigation and runoff flows were monitored and water samples taken for analysis. An analysis of variance showed no significant difference between the ground cover treatment means for any constituent, although there was a trend toward better pollutant retention with the alfalfa-fescue mixture. The amount of constituent loss through irrigation return flow from land wintering cattle seems to be small. (Moore-IVI)
W84-04460

CONSERVATION OF SOIL, WATER, AND ENERGY THROUGH REDUCED TILLAGE SYSTEMS — PHASE I SUB 1

Nebraska Univ. Lincoln, NE, Dept. of Agricultural Engineering. E.C. Dickey
Available from the national Technical Information Service, Springfield, VA 22161 as PB83-220012, Price codes: A05 in paper copy, A01 in microfiche. Nebraska Water Resources Center Completion Report, Univ. of Nebraska, Lincoln, NE, June 1983. 65 p., 11 Fig., 26 Tab, 31 Ref. OWRT B-052-NEB(1), 14-34-0001-0229.

Descriptors: *Soil erosion, *Soil conservation, *Erosion control, *Cultivation, Sedimentation, Soil management, Runoff, Precipitation, Mulching, *Nebraska, *Tillage systems, Simulated rainfall.

Soil erosion and sedimentation have been identified as major water quality problems in Nebraska. This project was initiated in 1980 to evaluate and demonstrate the influence of selected tillage systems on soil erosion, water runoff, nutrient loss, crop yield, fuel and energy use, and labor inputs. Tillage plots were established at two sites having different soil types and field slopes. Simulated rainfall, applied at the rate of 2.5 inches per hour, showed that soil erosion increased as the amount of residue remaining on the soil surface decreased. No-till planting, which left the highest percentage of soil surface covered with residue, resulted in the least amount of erosion, whereas the moldboard plow system has the most erosion. As little as a 20% residue cover reduced erosion by 50 percent of that which occurred from cleanly tilled, residue free soil conditions. Reducing or eliminating field operations also decreased fuel use and labor requirements for tillage and planting. No-till had fuel and labor requirements 75 and 50% lower, respectively, than the moldboard plow system. When cultural energy inputs were considered, no-till still used 10% less total energy than the moldboard plow system, even though pesticide use was higher with no-till. Simulated rainfall was effective for demonstrating differences in erosion from various tillage systems.
W83-03287

CONSERVATION TILLAGE EFFECTS ON WATER CONSERVATION

Kansas State Univ., Manhattan, KS, Dept. of Agricultural Engineering. J.M. Steichen, and R.W. LaForce.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-139865.

Price codes: A03 in paper copy, A01 in microfiche. Completion Report, Kansas Water Resources Research Institute, Manhattan, September 1982. 22 p., 7 Fig., 4 Tab, 13 Ref. OWRT A-098-KAN(1), 14-34-0001-0118.

Descriptors: *Kansas, Wheat, Grain sorghum, Agricultural, Rainfall-runoff, *Water conservation, *Rainfall simulator, *Infiltration, Fallow cycle, *Tillage.

A portable rainfall simulator was built and calibrated to determine effects of tillage practices on infiltration. The rainfall simulator can vary the application rate between 0.5 and 13.6 cm/h at a nozzle pressure of 41 kPa. The choice of two nozzles allows droplet size and kinetic energy similar to low intensity or high intensity rainstorms. The use of a rainfall simulator to determine rainfall-runoff properties of a soil cover complex is practical. The rainfall simulator was used as a field unit on pasture of Manhattan, Kansas and wheat ground at Colby and Hays, Kansas. Tillage practices studied are no till, stubble mulch and clean till. Tests were run at various times in the wheat fallow or wheat sorghum fallow cycle. In general the field data tend to support the estimated curve numbers obtained by reducing published curve numbers up to 10% for residue cover. Although there is some variation due to deep tillage or large cracks, these are relatively short term and would be greatly reduced by the next significant rain. It appears that runoff estimates from stubble mulched areas in northwest Kansas by reducing curve numbers for residue cover are reasonable.
W83-01240

CONSERVATION TILLAGE FOR EROSION CONTROL

National Soil Erosion Lab., West Lafayette, IN. W.C. Moldenhauer, G.W. Langdale, W. Frye, D.K. McCool, and R.I. Papendick.
Journal of Soil and Water Conservation, Vol. 38, No. 3, p. 144-151, May-June, 1983. 4 Fig., 6 Tab, 25 Ref.

Descriptors: *Erosion control, Soil conservation, Tillage, Farm management, Agriculture, Soil erosion, United States, Vegetation, Vegetation effects.

A region-by-region assessment is given of conservation tillage's effectiveness in controlling soil loss. In 1981 conservation tillage was used on one-third of the harvested cropland in the Corn Belt. The percentage of cropland in no-till was near the national figure of 2.5%. In the Corn Belt reduction of erosion seems to be a matter of leaving sufficient residue on the surface. In the Southeast it is important to break up the pan that forms each year in soil that is moldboard-plowed or even disked. Chiselling in the row breaks up the pan and allows moisture to get into the root zone, reducing runoff and erosion. In the Great Plains, wind erosion is generally more serious than water erosion. Living or dead vegetation, again, is more effective than surface roughness in reducing erosion. Vegetation lifts the wind and also increases the percentage of nonerodible aggregates in conservation tillage practices. In the Pacific Northwest, growing vegetation effectively reduces erosion once the vegetation is established. No-tillage seeding of wheat has proved successful in reducing erosion, though under deep frozen soil conditions it may not reduce runoff. Surface roughness and surface residue prevent a continuous frost layer under shallow frozen soil conditions and help to reduce runoff. (Baker-IVI)
W84-03059

CONTRIBUTION OF PHOSPHORUS LEACHED FROM CROP CANOPY TO LOSSES IN SURFACE RUNOFF

Sharpley, A.N. Journal of Environmental Quality; 10: No. 2, 160-165 (1981). Simulated rainfall (6 cm/hour) was used to leach P from growing cotton (Gossypium hirsutum), sorghum (Sorghum sudanense), and soybean (Glycine max.) plants as a function of soil type and time interval between rainfall events. The relative contribution of plant material and surface soil to the transport of soluble P in surface runoff was estimated. The amount of soluble P in plant leachate, collected before contacting the soil surface, was found to increase with plant age and soil water stress when changes in leaf area index were accounted for. A period of at least 1 day between rainfall events was needed for P to reaccumulate on the lead surface. The contribution of soluble P in plant leachate to that transported in surface runoff was estimated as the difference in runoff concentration between planted and bare soil. When plants were subject to a soil P stress, canopy leachate contributed the major proportion (90%) of that transported in surface runoff. With an increase in plant age from 42 to 82 days, the contribution of plant leachate to surface runoff increased from approximately 20 to 60%. The possible sorption of leached P is discussed along with estimating leaching losses in improving the predictive ability of nutrient models.

DEVELOPMENT OF A METHODOLOGY FOR IDENTIFYING CRITICAL NONPOINT POLLUTION AREAS IN AGRICULTURAL WATERSHEDS

Marquette Univ., Milwaukee, WI, Dept. of Civil Engineering. V. Novotny, T. Daniel, and R. Motschall.
Available from the National Technical Information Service, Springifled, VA 22161 as PB83-154393, Price codes: A03 in paper copy, A01 in microfiche. Water Resources Center Technical Report WIS WRC 82-03, University of Wisconsin, Madison, WI, 1982. 37 p., 12 Fig., 3 Tab, 45 Ref. OWRT A-082-WIS(1), 14-34-001-0153.

Descriptors: *Agricultural runoff, *Agricultural watersheds, Erosion, *Nonpoint pollution sources, Pollutants, *Sediment transport, Sediment yield, *Wisconsin, *Overland flow, Manure, Waste disposal.

Delivery of sediment and particulate pollutants from diffuse sources is shown to be related to the loss of sediment carrying energy of runoff during the overland flow phase. The loss is caused by the termination of rainfall and by reduction of flow energy during the recession phase of the overland flow hydrograph. Theoretical analyses and experimental measurements have demonstrated that the saturated sediment concentration in overland flow is a function of rainfall erosivity and the runoff flow rate. The hypotheses were verified by field measurements from a small homogeneous watershed. Critical manure management areas (CMMAs) are barnyards and manure disposal areas that are potential contributors to nonpoint pollution. Identifying and ranking a CMMA is a problem for the resource manager involved in solving nonpoint pollution problems on priority watersheds. An ideal method to identify CMMAs must be technically sound, inexpensive, and easy to administer. The goal of this portion of the project was to develop a procedure that identifies CMMAs which drain into intermittent waterways using soil samples.
W83-01793

DISTRIBUTION OF NITROGENOUS COMPOUNDS IN A RHODIC PALEUDULT FOLLOWING HEAVY MANURE APPLICATION

North Carolina State Univ. at Raleigh. J.R. Cooper, R.B. Reneau, Jr., W. Kroontje, and G.D. Jones.
Journal of Environmental Quality, Vol. 13, No. 2, p. 189-193, April-June, 1984. 3 Fig., 2 Tab, 22 Ref.

Descriptors: *Manure, *Nitrogen, *Water pollution sources, *Groundwater pollution, Nitrates, Nitrites, Ammonia, Leaching, Fertilizers, Decomposition, Path of pollutants.

Agriculture faces the problem of animal manure disposal while maintaining crop yields and soil water quality. There is an economic advantage of manure disposal at elevated rates close to the source. This in turn increases the potential for groundwater contamination. This study was conducted to determine the effect of high rates of cattle and poultry manure application on the N balance and on the distribution of NH4(+), NO3(-), NO2(-), and total N to a depth of 6 m in a Davidson clay loam soil (Rhodic Paledult, clayey, kaolinitic, thermic). Average dry weights of manure added per year (from 1972 to 1976) were 32, 61, and 121 Mg/ha for cattle and 94 and 184 Mg/ha for poultry waste. In addition to manure treatments, a fertilizer treatment and a control were also present. A N balance showed that while 36% of the inorganic fertilizer N applied was removed by the crop, with manure application < 10% of the total was crop recovered. The percentage of the total N in the upper 6 m of the soil profile generally decreased with increased manure N application, although N present increased with increased N applications. The unrecovered N, attributed primarily to denitrification losses, increased with increased N application and ranged from 6% for the fertilizer check to 58% for the highest rate of poultry manure. The primary inorganic N component in the soil was NO3(-)-N and the zone of maximum accumulation is between 2 and 2.5 m. The organic N fractions remaining in the soil profile could be adequately estimated using existing decay constants. The present study shows that the most feasible means of determining the quantity of manure to apply for crop growth and simultaneously reduced N leaching would be the use of decay series for manure decomposition combined with an estimate of atmospheric loss. (Author's abstract)
W84-05113

DRAINAGE-TILLAGE INTERACTION ON CLERMONT SOIL

Agricultural Research Service, Columbus, OH. N.R. Fausey. Transactions of the ASAE, Vol. 27, No. 2, p.403-406, March-April, 1984. 5 Fig., 4 Tab, 4 Ref.

Descriptors: *Ohio, *Clermont soil, *Drainage, *Tillage, Plowing, subsurface drainage, Corn, Crop production, Crop yield, Raised beds, Surface drainage, Soil water. Spring chisel plowing, no-tillage, and no-tillage on permanent beds are the tillage systems which were compared on Clermont silt loam soil in southwest Ohio. Subsurface drainage was by means of shallow, small diameter draintubes, and the influence of the subsurface drainage was evaluated by measuring the stand and yield of corn at various distances from the drain lines. The tillage treatments significantly affected both population and yield. The plant population was not affected by distance from the subsurface drains, while the yield was significantly related to the distance. The subsurface drainage and the

tillage effects were independent. The additional surface drainage resulting from the raised beds had a highly significant effect on the performance of the no-tillage system and could form the basis for the successful use of no-tillage practices on this type of soil. (Author's abstract)
W85-01184

DYNAMIC SIMULATION OF SEDIMENT DISCHARGE FROM AGRICULTURAL WATERSHEDS

Agricultural Research Service, Columbia, MO. M.W. Van Liew and K.E. Saxton.
Transactions of the ASAE, Vol. 27, No. 4, p. 1087-1092, July/August, 1984. 5 Fig., 3 Tab, 19 Ref.

Descriptors: *Sediment discharge, *Agricultural watersheds, *Watersheds, *Soil erosion, *Simulation analysis, Runoff, Model studies, Erosion.

Soil erosion and sediment transport from small agricultural watersheds in southwestern Iowa were estimated by applying a modified version of the SEDLAB simulation model. The effects of crop canopy, groundcover, and subsurface land use effects were represented by revised and newly developed functions. The results showed that the revised SEDLAB model will provide reasonably accurate estimates to the erosion and sediment discharge of upland agricultural watersheds for different hydrologic, vegetative , and cultural conditions. Tests with data from an adjacent watershed showed that the model may be transferred to similar uncalibrated watersheds. (Author's abstract)
W85-03401

EFFECT OF CROP RESIDUE TILLAGE-INDUCED ROUGHNESS, AND RUNOFF VELOCITY ON SIZE DISTRIBUTION OF ERODED SOIL AGGREGATES

N.P. Cogo, W.C. Modenhauer, and G.R. Foster. Soil Science Society of America Journal, Vol. 47, No. 5, p.1005-1008, September-October, 1983. 5 Fig., 16 Ref.

Descriptors: *Soil erosion, *Soil aggregates, *Tillage, *Crop residues, *Velocity, Plowing, Flow rate, Sediment transport, Conservation tillage, Roughness.

The percentage of eroded soil aggregates over 10 size classes ranging from 0.002 to 2.0 mm in diameter as affected by crop residue cover, tillage-induced roughness, and water flow velocity were investigated under field conditions using simulated rainfall. The soils used were a 4.5% slope Russell silt loam and a 6.5% slope Martinsville loam. With no vegetation present, the smallest eroded aggregates came from a chisel-plowed surface while the largest came from chisel- and moldboard-plowed surfaces which had been disked. A no-till treatment gave intermediate values. The D50 size (the aggregate size which 50% of the aggregates exceed) in the absence of soil cover was 0.033, 0.032, 0.020, and 0.011 mm for chisel plow plus disk, moldboard plow plus disk, no-till and chisel plow, respectively. When soil was covered by residue, and size distribution of the eroded aggregates was not greatly different among the tillage treatments. The D50 size was reduced in this case to about 0.012 mm for all tillage systems. For no-till, the percentage of the eroded aggregates > 0.05 mm decreased exponentially (r(2) = 0.85) with an increase in residue cover. Under chiesel plowing residue was not effective in reducing the quantity of larger aggregates in the runoff. An increase in the flow rate caused an increase in water flow velocity which, in turn, caused a linear (r(2) = 0.94) increase in the percentage of the eroded aggregates > 0.05 mm, for chisel plowing. The results from this study were explained in terms of sediment trapping capacity of the soil surface, as well as runoff transport capacity. (Author's abstract)
W84-01877

EFFECT OF SUBSURFACE DRAINAGE ON RUNOFF AND SEDIMENT YIELD FROM AN AGRICULTURAL WATERSHED IN WESTERN OREGON, U.S.A.

Oregon State Univ., Corvallis or Dept. of Soil Science J.D. Istok and G.F. Kling.
Journal of Hydrology, Vol. 65, No. 4, p. 279-281, September, 1983, 8 Fig., 3 Tab, 10 Ref.

Descriptors: *Subsurface drainage, *Erosion control, *Agricultural watersheds, *Sediment yield, *Oregon, Willamette Valley, Drainage, Runoff, Storm runoff.

Continuous measurements were taken for four winter rainfall seasons of rainfall, watershed runoff and suspended sediment concentrations for three tion in the microflora favoring those species that tolerate higher silver concentrations. This corresponds with observations on applying silver compounds in practice. Routined bacteriological monitoring is recommended when these compounds are put to practical use. (Author's abstract)
W84-02142

EFFECTS OF FARMING PRACTICES ON SEDIMENT IN IRRIGATION RETURN FLOW

Washington State Univ., Pullman, WA, Dept of Agricultural Engineering. L.G. King and A.C. Janke.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-206862, Price codes: A06 in paper copy, A01 in microfiche. Water Research Center Completion Report, Washington State Univ., Pullman, March 1983. 91 p., 8 Fig., 11 Tab, 23 Ref., 1 Append. OWRT B-067-WASH(2), 14-34-0001-7197.

Descriptors: *Irrigation return flow, Irrigation tailwater, Sediment, Sediment basins, Furrow irrigation, Irrigation efficiency, *Washington, Soil erosion, Sulphur Creek drainage basin, Cultivation.

The overall objective of the research was to assist in determining the success of the Sulphur Creek Demonstration Project in reducing sediment in irrigation return flow by changing farming practices on irrigated lands. Although this demonstration project was terminated prematurely by the agencies conducting it, some valuable results were obtained. It was determined that a small percentage of irrigators cause a large fraction of the sediment content of irrigation return flows. For fourteen different sites, only three in 1977 and four in 1978 had net seasonal sediment loss in excess of 3 tons/acre. Studies of field performance of sediment basins gave valuable information on the particle size distributions of sediment in irrigation tailwater and the load of sediment carried by tailwater under various field and crop conditions. These latter two types of data are almost non-existent and yet very necessary for proper design of sediment basins. Procedures were developed and tested to provide irrigators with tools for evaluation of their irrigation practices. If properly applied, these procedures can determine whether for given field conditions, changes in water management to control sediment discharge are possible or whether a change in the irrigation system is necessary. W83-03039

EFFECTS OF SPECIFIC LAND USES ON NON-POINT SOURCES OF SUSPENDED SEDIMENT, NUTRIENTS, AND HERBICIDES-PEQUEA CREEK BASIN, PENNSYLVANIA 1979-80

Geological Survey, Harrisburg, PA. Water Resources Div. P.L. Lietman, J.R. Ward, and T.E. Behrendt.
Available from OFSS, USGS, Box 25425, Fed. Ctr., Denver, CO 80225. USGS Water-Resources Investigations Report 83-4113, 1983. 88 p., 41 Fig., 16 Tab, 24 Ref.

Descriptors: *Storm runoff, *Pesticides, *Phosphorus, *Nitrate, *Nitrogen, *Sediment, *Land use, Agricultural watersheds, *Water quality, Transport, *Pennsylvania, Susquehanna River basin, Lancaster County, Pequea Creek.

Land use effects on water quality of receiving streams were examined in Pequea Creek basin, an agricultural area draining into the Susquehanna River. Streamflow was measured and base-flow and composite storm samples were analyzed for suspended sediment, nutrients, and triazine herbicides from Pequea Creek and specific land-use subbasins (forest, corn, rural residential, and pasture). Maximum base-flow concentrations of the constituents were: total organic nitrogen and phosphorus from the pasture, total nitrate nitrogen (about double the U.S. Public Health standard of 10 milligrams per liter) and atrazine from the corn site, prometone from the residential site, and simazine from Pequea Creek. The highest mean storm concentrations of suspended sediment were from the corn site, of organic nitrogen from the corn and pasture sites, and of nitrate nitrogen, phosphorus, and atrazine concentrations from the corn site. Phosphorus and atrazine concentrations from the corn site. Phosphorus and atrazine concentrations were highest during intense storms following fertilizer and herbicide applications. Constituent loads from Pequea Creek during some months significantly increased the loads of nitrate nitrogen and suspended sediment of the Susquehanna River. The loads, in tons, from Pequea Creek in 1980 with 100,000 acre-feet of water were: suspended sediment, 12,000; nitrate, 840; organic nitrogen, 72; phosphorus, 21; organic carbon, 540; atrazine, 0.05; simazine, 0.03; and prometone, less than 0.01. (USGS) W85-00855

EFFECTS OF SURFACE APPLICATION OF DAIRY MANURE ON THE INFILTRATION RATE AND QUALITY OF SURFACE RUNOFF

Kentucky Water Resources Research Inst., Lexington, KY,J. L. Tarab, I.J. Ross, J.D. Bottom, and B.J. Barfield. Available from the National Technical Information Service, Springifled, VA 22161 as PB83-222422, Price codes: A05 in paper copy, A01 in microfiche. Research Report No.138, June 1983. 86 p., 10 Fig., 18 Tab, 47 Ref., 1 append. OWRT A-018-KY(1), 14-34-0001-0119.

Descriptors: *Agricultural runoff, *Animal wastes, *Manure, *Non-point pollution sources, Pollution load, Soil treatment, Kentucky, Dairy manure, Loam, *Infiltration rates, Nitrogen.

Dairy manure was surface spread on 12 ft x 12 ft plots on an established fescue pasture in the summer and fall of 1981 and 182. The soil was a Murray silt loam. A simulated rainfall was applied to plots to test the effects of nitrogen rate 75, 150, and 300 No N/acre) time delay between manure application and the simulated rainfall events (o, 3, 6, 24, 48, 96 hours and 120 hour test repeated on 0 hr plot with 300 No N/acre), and type manure (semi-solid — 1981 and liquid — 1982) on the concentrations of pollutants in the surface runoff. The pollutants measured were COD, TSS, FSS, VSS, TS, FS, VS, NO sub 3, NH sub 4, N, P, and K. The simulated rainfall rates were 3.42 in/hr for 1981 and 4.02 for 1982. The average field infiltration rate for the non-manured test plots were 3.40 in/hr in 1981 and 4.42 in/hr in 1982. The infiltration rates of the manured plots were reduced by 5.8 to 15% for semi-solid manure and 23 to 31% for liquid manure for zero hour time delay plots. The infiltration rates increased to within 92% of the control plots after 120 hour time delay. The pollutant yields increased with nitrogen loading rate except for FSS yield which remained below the control plot yields. The NO sub 3 yields was below the control plot except for 300 No N/acre plots. The reduction in pollutant yields with increased time dealy was found to average 46 to 76% for the 24 and 48 hour time delays for semi-solid manure and 75 and 94% for liquid manure. The yields for TSS, FSS and VSS for liquid manure did not exceed the control after 48 hours. W83-03344

FARMERS' ATTITUDES TOWARD GOVERNMENT INVOLVEMENT IN PREVENTING AGRICULTURAL NONPOINT SOURCE WATER POLLUTION

Purdue Univ., Lafayette, IN, Dept. of Agricultural Economics. F.D. Parent and S.B. Lovejoy.
Water Resources Bulletin, Vol. 18, No. 4, p. 593-597, August, 1982. 5 Tab, 12 Ref.

Descriptors: *Erosion control, *Conservation, *Farming, *Indiana, Financial aspects, Water pollution sources, Nonpoint pollution sources, Sedimentation, Pollution load.

At present agricultural lands are producing vast amounts of sediment, which is a primary cause of water pollution. However, if erosion control practices were more widely adopted, this problem could be lessened. Farmers on a small watershed in northeastern Indiana were interviewed before and after a major demonstration project focusing upon the control of erosion was performed. A majority of the farmers felt that those who adopt pollution control techniques should not pay their entire cost. Over 60% of the farmers also believed that the federal government should play an important role in soil conservation programs. However, fewer respondents were willing to use federal taxation to completely clean up the water resources. A majority of the respondents indicated that the individual landowner should be responsible for controlling the soil erosion problem. These findings suggest the farmers want assistance from the government, but feel that the individual landowners should retain the right to decide on the land use practices to be employed on their own farms. (Baker-FRC)
W83-01506

FATE AND EFFECTIVENESS OF TEBUTHIURON APPLIED TO A RANGELAND WATERSHED

Lilly (Eli) and Co., Indianapolis, IN. Lilly Research Lab. W.E. Emmerich, J.D. Helmer, K.G. Renard, and L.J. Lane.
Journal of Environmental Quality, Vol. 13, No. 3, p. 382-386, July-September, 1984. 2 Fig., 4 Tab, 18 Ref.

Descriptors: *Fate of pollutants, *Herbicides, *Tebuthiuron, *Rangeland, Brush control, Runoff, suspended solids, Range management, Groundwater pollution.

Tebuthiuron, a herbicide, was applied at a rate of 0.84 kg/ha to a rangeland watershed and test plots in pelleted and dissolved forms, respectively. The removal of tebuthiuron in the runoff water from the watershed was determined for each runoff event. The total tebuthiuron removed from the rangeland watershed in the runoff water and suspended sediment over two seasons was 0.47% of the amount applied. Tebuthiuron removal associated with the bedload sediment was negligible. The low total removal of tebuthiuron in runoff water was believed to be due to the timing of the application. Tebuthiuron was applied at a time when precipitation rates are expected to be less than the infiltration rate, but when winter precipitation would be sufficient to leach at least some of the chemical into the soil profile. It is recommended that this procedure be followed for tebuthiuron application to minimize the probability of removals in runoff. Tebuthiuron moved to a depth of 17 cm in 8 months with 326 mm of precipitation, and remained at that depth despite additional precipitation. The total tebuthiuron remaining in the test plots after 21 months was 38% of that applied. Regression equations were developed that predicted the tebuthiuron would persist from 2.9 to 7.2 yr before the amount in the test plots would fall below the detection limit. Significant differences in the estimated time required to reach the detection limit of tebuthiuron in the test plots emphasizes the difficulty in predicting precisely the disappearance of chemicals released in the environment and the need for longer periods of actual sampling and analysis. Tebuthiuron, applied at a rate of 0.84 kg/ha, was effective in reducing the dominate brush species on the watershed, producing 100% kill for tabush, fourwing saltbush, and little leaf sumac after 615 d, and lower percentages for creosotebush (61%), whitethorn (92%), and graythorn (0%). (Baker-IVI)
W85-01285

FIELD TO STREAM TRANSPORT OF AGRICULTURAL CHEMICALS AND SEDIMENT OF AN IOWA WATERSHED: PART I. DATA BASE FOR MODEL TESTING (1976-1978)

Iowa Sate Univ., Ames, IA, H. P. Johnson and J.L. Baker. Available from the National Technical Information Service, Springfield, VA 22161 as PB82-254046, Service, Springfield, VA 22161 as PB82-254046, Price codes: A25 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S3-82-032, September 1982. 4 p., 1 Fig., 3 Tab.

Descriptors: *Agricultural runoff, *Sediments, *Soil erosion, *Pesticides, *Surface runoff, Iowa, Herbicides, Nitrogen compounds, Agricultural chemicals, Agricultural watersheds, Storm seepage, Nonpoint sources, Precipitation, Streamflow.

In order to provide information for testing and evaluating mathematical models under development for predicting agricultural nonpoint source pollution, data were collected for small corn, soybean, and pasture fields; for two larger mixed cover watersheds; and at three drainage-stream sites. The study area was located in the upper portion of the Four Mile Creek watershed in Tama County, Iowa. Precipitation during the study averaged 92% of normal. Average annual stream-flow from the whole watershed was 125 mm. Sediment losses were also low because of a lack of intense rains, averaging 2.6 t/ha from row-crops and 0.9 t/ha from the watershed as a whole. Average surface runoff losses from pasture, corn, and soybean fields of all dissolved chemicals were less than the amount depositied by precipitation. Because nitrite-nitrogen, chlorine and total dissolved solids were concentrated in subsurface drainage, losses from the watershed as a whole due to streamflow (surface plus subsurface drainage) were significantly larger than losses from surface runoff alone. Average annual pesticide losses from the field were least for the shortest-lived herbicide and greatest for the most persistent. Losses of the herbicides with streamflow from the whole watershed, on a percentage of applied basis, were about 25% of the edge of field losses with the exception of the strongly absorbed paraquat, at least 80% of the basses occurred in the water phase as opposed to that absorbed on sediment. (Moore-SRC)
W83-02041

HERBICIDE RUNOFF FROM EXPERIMENTAL WATERSHEDS

Smithsonian Institution, Edgewater, MD. Chesapeake Bay Center for Environmental Studies. T.L. Wu, D.L. Correll, and H.E.H. Remenapp.

Journal of Environmental Quality, Vol. 12, No. 3, p. 330-336, July-September, 1983. 4 Fig., 4 Tab, 19 Ref. EPA grant R804536-01.

Descriptors: *Atrazine, *Alachlor, *Herbicides, *Water pollution sources, Nonpoint pollution sources, Path of pollutants, Agricultural runoff, Agricultural watersheds, Pesticide residues, Rhode River Watershed, Maryland.

Two commonly used herbicides in corn fields of the Rhode River Watershed (Maryland) were atrazine (2-chloro-4-ethylamino-6-iso-proplylamino-1,3,5-triazine) and alachlor (2-chloro-2',6'-diethyl-N-methoxymethyl acetanilide). Although alachlor was applied in larger quantities, atrazine was detected more frequently in runoff waters and had greater concentrations than alachlor (0-4 micro g/L vs. 0-6 micro g/L). Atrazine was more persistent and more mobile in watershed soils. Linear regression analysis of herbicde loading rates and percentage agricultural land use did not give a direct relationship. Runoff waters from forest watersheds where herbicides were not directly applied, were contaminated with herbicides. During the 3-6 study period (1976-1978), a maximum of 10 micro g/L of atrazine, and up to 0.5 micro g/L alachlor were discharged in winter runoff waters from the eight experimental watersheds. In addition to quantity of herbicides directly applied to land surface, by other important factors such as topography, location of croplands in relationship to drainage channel, etc. A major portion of atrazine was found in dissolved aqueous form in runoff-water samples collected during storm events. Percolation in subsurface flow and dissolution in overland flow were believed to be important transport mechanisms. (Author's abstract)
W84-01806

HYDROLOGY AND SOIL LOSS FROM A HIGH-FERTILITY, ROTATIONAL PASTURE PROGRAM

Science and Education Administration, Coshocton, OH, L.B. Owens, R.W. VanKeuren, and W.M. Edwards,

Journal of Environmental Quality, Vol. 12, No. 3, p 341-346, July-September, 1983. 2 Fig., 6 Tab, 14 Ref.

Descriptors: *Agricultural runoff, *Grazing, *Cattle, *Soil loss, Vegetation, Environmental effects, Pasture management, Precipitation, Ohio.

Five small watersheds (0.25-3.1 ha) on sloping uplands in eastern Ohio were used to evaluate environmental effects of a beef management program of rotational winter grazing/feeding with stored hay on another area. During the 5-y study, annual precipitation was 1080 mm, which was 8-15% greater than the long-term average. The surface runoff was measured by precalibrated H-flumes, and automatically sampled using Coshocton wheels. Surface runoff from watersheds with beef cattle management increased, compared with the long-term averages when hay was grown on the watersheds. Greater precipitation was the primary factor causing more runoff during the growing season (May-October), and the cattle management was a major contributing influence on the runoff increase during the dormant season (November-April). Maintenance of good vegetative cover on the study areas was a major factor in limited annual average surface runoff to < 110 mm, which was a relatively small amount. The large runoff events, although a small percentage of the total number of events, produced most of the runoff volume. Soil loss from these pastures was minimal. (Author's abstract)
W84-01807

IMPACT OF SNOWMELT-RUNOFF FROM AGRICULTURAL WATERSHEDS ON DISSOLVED OXYGEN

Wisconsin Dept. of Natural Resources, Rhinelander. J.F. Sillivan.

Journal of the Water Pollution Control Federation, Vol. 55, No. 2, p. 170-177, February, 1983. 6 Fig., 2 Tab, 16 Ref.

Descriptors: *Snowmelt, *Agricultural runoff, *Nonpoint pollution sources, Fish kills, Agricultural wastes, Animal wastes, Dairy industry, *dissolved oxygen, Upper Wisconsin River, Agricultural watersheds, Runoff, Watersheds, Water pollution sources, Fate of pollutants, *Wisconsin.

Dissolved oxygen levels dropped to as low as 2 mg per liter in some sections of the Upper Wisconsin River on March 28, 1980, shortly after the season's first major runoff event. Fish kills occurred in Big Eau Pleine Reservoir. An investigation of water quality in tributaries and at pulp and paper plants revealed that the source of pollution was agricultural wastes such as animal and cheese wastes applied to fields. This nonpoint pollution source was not recognized previously for several reasons. An extensive automatic monitoring system has been installed. Excessive paper mill discharges, which have been reduced by pollution control, formerly masked the impact of agricultural wastes. Below normal snowfall and long periods of bare frozen soil that winter facilitated spreading of manure and cheese wastes. Nonpoint source pollution control should be implemented in problem watersheds. (Cassar-FRC)
W83-03636

IN SITU MEASURES OF DISSOLVED ORGANIC CARBON FLUX IN A RURAL STREAM

Moravian Coll., Bethlehem, PA. Dept. of Biology. F.T. Kuserk, L.A. Kaplan, and T.L. Bott.

Canadian Journal of Fisheries and Aquatic Sciences, Vol. 41, No. 6, p. 964-973, June, 1984. 4 Fig., 3 Tab, 25 Ref. NSF grant DEB 79-21963.

Descriptors: *Organic carbon, *Dissolved solids, *Streams, Algal growth, Manure, Solar radiation, Microcosms, Diel variation.

Dissolved organic carbon (DOC) dynamics were measured in a second-order stream located in a pasture in southeastern Pennsylvania. In situ measurements made at six stations in early summer showed a diel pattern of net DOC release from the streamed communities with predawn minima and afternoon maxima. When a 18-m section of the stream was covered with black plastic for 1 mo to exclude algal growth and measures were repeated in late summer, a net removal of DOC occurred in the covered section, while in an adjacent uncovered section DOC was released. When a bovine manure extract was introduced into the covered section, the DOC removal rate increased by more than an order of magnitude. Jewel-weed (Impatiens capensis L.) extract also elicited an elevated rate of DOC removal. When these extracts were added individually to microcosms, removal rates in the dark were 57 to 65% of the in situ uptake estimates for the manure extract and leachate, respectively. Abiotic controls showed that nearly all of the DOC removal was biotic uptake. DOC flux measurements in a third-order section of White Clay Creek located on an adjacent watershed, also revealed a net DOC release from the uncovered stream bed. Introduction of a bovine manure extract elicited a DOC removal rate an order of magnitude less than in the pasture stream. A companion microcosm experiment yielded an uptake rate that was 178% of the in situ estimate. (Author's abstract)
W85-01493

INFLUENCE OF AGRICULTURAL DRAINAGE ON WATER QUALITY

Delaware Univ., Newark, DE, Dept. of Agricultural Engineering. W.F. Ritter.

Available from the National Technical Information Service, Springfield, VA 22161 as PB83-220327. Water Resources Center Completion Report, Univ. of Delaware, Newark, April 1983, 32 p., 2 Fig., 18 Tab, 20 Ref. OWRT A-056-DEL(1), 14-34-0001-2108.

Descriptors: Water quality, *Surface drainage, *Nitrogen, *Phosphorus, *Agricultural watersheds, Agricultural hydrology, *Delaware, Landuse, Marshyhop Creek watershed, Pepper Creek watershed, Upper Choptank River watershed.

Three agricultural watersheds located in western Kent Co. in the Choptank River basin were monitored from March to September, 1982. Drainage construction was in progress on one of the watersheds, another watershed had no drainage construction, and the third watershed had drainage constructed approximately ten years of age. Storm runoff and baseflow samples were analyzed for ammonia, nitrate nitrogen, organic nitrogen, ortho phosphorus, total phosphorus, turbidity, suspended solids, and dissolved solids. Ongoing drainage construction had more impact on baseflow chemical parameters concentrations than storm runoff concentrations. On the watershed where drainage construction was in progress, nitrate nitrogen, total phosphorus, turbidity, suspended solids, and dissolved solids concentrations were increased. Suspended solids concentrations were higher on the watershed where no drainage has been constructed for some storms because of sediment flotation.
W83-03289

INFLUENCE OF CONSERVATION TILLAGE ON SOIL PROPERTIES

Kentucky Agricultural Experiment Station, Lexington, KY, Dept. of Agronomy. R.L. Blevins, M.S. Smith, G.W. Thomas, W.W. Frye.

Journal of Soil and Water Conservation, Vol. 38, No. 3, p.301-305, May-June, 1983. 3 Fig., 5 Tab, 18 Ref.

Descriptors: *Soil water, *Tillage, *Water conservation, Magnesium, Calcium, Nutrients, Nitrogen, Soil permeability, Moisture loss, Moisture stress, Permeability coefficient.

In a long term tillage study, higher soil moisture under no-till crop production was observed as compared with that under conventional tillage throughout the growing season. Under no-till significantly less evaporation occurred in the growing season. This conservation of soil water may carry the no-till crop through short drought periods without severe moisture stress becoming evident in the plants. Under conditions of excess soil water, however, the extra water conserved under no-till can be detrimental and contribute to denitrification losses. There was no problem with soil compaction in no-tillage soils. Better water movement was noted in no-tillage compared with conventional tillage plots as determined by saturated hydraulic conductivity measurements. No deterioration of soil physical properties was noted after 10 years of continuous no-till corn production. Rapid acidification of the soil surface when high nitrogen fertilizer rates were used was the most obvious chemical change. Increased levels of exchangeable aluminum and manganese were associated with reduced soil pH. Exchangeable calcium was significantly lower for no-till at depths and all nitrogen fertilizer rates compared with conventional tillage. Potassium was concentrated in the 0- to 5-centimeter soil layer under no-till and decreased with depth. Exchangeable magnesium in the 0- to 5-cm soil depths declined with increasing nitrogen fertilizer and was lower in no-till soil depth compared with conventional tillage. Organic matter was twice as high in the 0-5 cm soil depth compared to conventional tillage. This modified soil environment affects chemical reactions and the distribution and activity of microbes. (Baker-IVI)
W84-02561

INFLUENCE OF LIVESTOCK ON NONPOINT SOURCE NUTRIENT LEVELS OF STREAMS

Tennessee Valley Authority, Knoxville, TN. A.M. Duds and D.S. Finan.

Transactions of the American Society of Agricultural Engineers, Vol. 26, No. 6, p. 1710-1716, November-December, 1983. 6 Fig., 5 Tab, 19 Ref.

Descriptors: *Livestock, *Nonpoint pollution sources, *Nutrients, *North Carolina, Drainage, Forest watersheds, Nitrogen, Phosphorus, Animal wastes, Storm runoff.

Ten agricultural watersheds with widely varing populations of livestock were instrumented to collect samples of lowflow and storm-event nutrient concentrations. Conducted in the Piedmont and Coastal Plain of North Carolina, the investigation demonstrated that much higher concentrations of nutrients occur in watersheds with extensive artificial drainage and larger nonpoint source populations of livestock than in similar agricultural watersheds with low populations of livestock. In addition, comparisons were made with nutrient levels previously recorded in forested watersheds in North Carolina. For total phosphorus, agricultural watersheds without high populations of livestock had mean concentrations 5 to 10 fold greater than mostly forested watersheds, while those with high populations of livestock approached 50 fold increases. For total inorganic nitrogen, the increases over forested watersheds approached 100 fold for agricultural watersheds with high populations of livestock. Observations are made concerning the production of stormflow from variable source areas in the watershed and the significance of animal waste and agricultural drainage improvements in causing elevated levels of nutrients in coastal waters. (Author's abstract)
W84-04479

INFLUENCE OF LONG-TERM TILLAGE AND CROP ROTATION ON WATER EROSION

Ohio Agricultural Research and Development Center, Wooster, OH. D. M. Van Doren, Jr., W.C. Moldenhauer, and G.B. Triplett, Jr.
Soil Science Society of America Journal, Vol. 48, No. 3, p. 636-640, May-June, 1984. 3 Tab, 16 Ref.

Descriptors: *Soil erosion, *Tillage, *Crop rotation, Soybeans, Corn, Soil loss, Soil management, Simulated rainfall, Rainfall runoff.

Soybeans (Glycine max. L.) apparently predispose a field to greater erosion by water than does corn (Zea mays L.) at equal residue cover. Most of the available data have been obtained from locations with 5 years or less history of a specific management. This study measured soil loss during simulated rainfall from plots having an 18-yr history of management to ascertain deviations, if any, from current expectations. The soil was a fine-loamy, mixed mesic, Typic Fragiudalfs having an average slope of 3%. Tillage variables included no-tillage, spring plow 20 cm deep, and spring plow 20 cm deep followed by 10 cm deep disking or equivalent. Rotations were continuous corn or corn-soybeans. Kinetic energy of applied water was about 70% of natural rainfall at 63 mm/h rate. Runoff and soil loss were measured at 60-s intervals during the 30- to 60-min runs. Soil loss per unit of rainfall following either crop in the corn-soybeans rotation was 45% greater than from continuous corn, after accounting for differences in residue cover by use of the Universal Soil Loss Equation (USLE). Soil loss per unit of rainfall for land not tilled for 1 or over 20 years was 90% less than expected according to the current version of the USLE. (Author's abstract)
W85-00755

INVESTIGATIONS OF STRATEGIES FOR REDUCING AGRICULTURAL, NONPOINT SOURCES IN THE CHOWAN RIVER BASIN

North Carolina State Univ. at Raleigh. Dept. of Biological and Agricultural Engineering. F.J. Humenik, B.A. Young, and F.A. Koehler.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-113562, Price codes: A09 in paper copy, A01 in microfiche. North Carolina Water Resources Research Institute Completion Report, September 1983. 172 p., 8 Fig., 29 Tab, 21 Ref., 6 Append., OWRT A-110-NC(1), 14-34-0001-1135.

Descriptors: *Nonpoint pollution sources, Agricultural runoff, *Agricultural watersheds, Erosion control, Nitrogen, Phosphorous, Biological samples, Soil absorption capability, *Management practices, *Chowan River Basin, Stream discharge data, Water quality data, Watershed soils.

A three-year study was conducted in the Chowan River Basin to measure water quality changes resulting from implementation of best management practices (BMP's) to reduce agricultural nonpoint sources. Important components of the overall study framework were to conduct surveys for assessing agricultural practices and producer attitudes associated with the development and evaluation of an agricultural nonpoint source control program and to conduct a supportive publicity, educational and technical assistance program. A cooperatively executed field sampling program resulted in over 13,000 actual USGS flow values, and 876 concentration samples. Predictive models were developed to fill data gaps and allow calculation of annual yields. The total complement of data obtained in this study emphasized th need of employing the total systems approach in conducting and evaluating nonpoint source control programs on a watershed basis. Important components of this total systems approach are recommendations to control agricultural nonpoint sources and methods for evaluating water quality changes. Study results lead to a better definition and documentation of the advantages and limitations of monitoring to determine actual land loading coefficients and to evaluate specific relationships between BMP's installed, and resulting water quality changes on a watershed basis.
W84-00134

LAND APPLICATION OF SEWAGE SLUDGE WITH REGARD TO CROPPING SYSTEMS AND POLLUTION POTENTIAL

Higgins, A.J. (Rutgers Univ., New Brunswick, NJ). Journal of Environmental Quality; 13: No. 3, 441-448 (July-Sep 1984).

Aerobically digested liquid sewage sludge was applied to Sassafras sandy loam soils (typic Hapludults), characteristic of the eastern coastal plan, for 3 consecutive years. Sludge was applied at rates of 0, 22.4, and 44.8 Mg of dry solids/ha in June of each year. Groundwater, soil, and crops were monitored for 4 years to establish the effects of high rates of sludge application. The results indicate that sludge application of 22.4 Mg of dry solids/ha on Sassafras sandy loam soil, or other similar sandy loam soils, is the upper limit to ensure protection of the groundwater quality. Annual applications of sludge at 44.8 Mg of dry solids/ha resulted in gross contamination of the groundwater by NO_3-N and other salts. However, no contamination of the groundwater by heavy metals was detected at either sludge loading rate. Fecal coliform levels were low throughout the duration of this study. Zinc and copper accumulated in the A soil horizon; however, no accumulation occurred in the B horizon. Corn (Zea mays) and rye (Secale cereale) yields were greatly enhanced by the addition of sludge but there was little difference in yield between the sludge loading rates. Uptake of heavy metals in the corn and rye occurred in response to sludge application. Zinc was the only metal that consistently appeared at levels above the control.

LONG-TERM ANNUAL RUNOFF AND SOIL LOSS FROM CONVENTIONAL AND CONSERVATION TILLAGE OF CORN

Agricultural Research Service, Columbia, MO. R.E. Burwell and L.A. Kramer.

Journal of Soil and Water Conservation, Vol. 38, No. 3, p. 315-319, May-June, 1983. 5 Fig., 1 Tab, 14 Ref.

Descriptors: *Soil conservation, *Tillage, Runoff, Erosion control, Erosion, Missouri, Claypan, Soil loss, Corn, Farm management.

Conservationists recognize that maximum average soil loss rates that would permit maintenance of crop production need to be specified for conservation system design. A central Missouri claypan soil had runoff and soil loss for conservation tillage 85 and 42%, respectively, of that for conventional tillage. Annual soil loss was 54 and 63% of the average annual predicted soil loss for conventional and conservation tillage, respectively. Runoff for corn after corn using conservation tillage was 13% less than that for conventional tillage. Soil loss for corn after corn using conservation tillage was 58% less than that for conventional tillage. Average annual soil losses for both tillage treatments on a 27.4 m long slope were less than the T-value of 6.7 metric tons per hectare per year currently used in conservation planning. (Murphy-IVI)
W84-03064

LONG-TERM EFFECTS OF MANURE ON SOIL NITROGEN, PHOSPHORUS, POTASSIUM, SODIUM, ORGANIC MATTER, AND WATER INFILTRATION RATE

Agricultural Research Service, Shafter, CA. Cotton Research Station. B. Meek, L. Graham, and T. Donovan.

Soil Science Society of American Journal, Vol. 46, No. 5, p. 1014-1019, September/October, 1982. 2 Fig., 6 Tab, 14 Ref.

Descriptors: *Water infiltration, *Minerals, *Land disposal, Sewage disposal, Manure, Land application, Nitrogen, Phosphorus, Nutrients, Sodium, Bicarbonates, Dentrification, Soil water, Permeability, Mineralization, *California.

Changes in soil physical and chemical properties were measured during a 9 year period in plots receiving various rates of manure application. High rates of manure were added to field plots of Holtville silty clay soil in an irrigated desert region. Manure applications resulted in large losses of N, increased levels of K, increased P availability, increased water intake rates during the growing season, and an N mineralization rate of about 5% after the first year. At high rates of application only 42% of the N applied could be accounted for. One application of 180 t/ha of manure in 1971 doubled the sodium bicarbonate extractable P levels in the soil in 1979 compared with that of plots that did not receive manure. The application of manure had only a small or no effect on the water intake rate when it was measured between cropping periods on plots that had been recently killed, but differences were large when water intake rates were measured while the crop was growing. The increased water infiltration rates during the growing season would be important because of increased crop yields in areas affected by salinity. (Baker-FRC)
W83-04043

NITRATE LEACHING FROM GRASSLAND

Grasslands Research Inst., Hurley (England). J.C. Ryden, P.R. Ball, and E.A. Garwood. Nature, Vol. 311, No. 5981, p. 50-53, September, 1984. 1 Fig., 3 Tab, 27 Ref.

Descriptors: *Nitrates, *Grasslands, *Leaching, *England, Animal wastes, Grazing, Pastures, Water pollution sources, Fertilizers.

Increased awareness of the economic importance of losses of nitrogen from agricultural land, together with the recognition that nitrate in drinking water is potentially detrimental to human health, have stimulated research on nitrate leaching. Substantial amounts of nitrate can be leached from intensively farmed grassland as well as when grassland is ploughed in a ley-arable system. The most striking feature is the effect of ruminant production on nitrate leaching. The annual loss of nitrate from a grazed grass sward was 5.6 times greater than that below the comparable cut sward, despite a common input of fertilizer N and defoliation frequency. The enhanced nitrate movement below the grazed sward can be attributed mainly to the return in urine and dung of as much as 90% of the N in the herbage consumed by cattle. AT the end of the grazing season in October 1982, the mean nitrate content of soil below urine- and dung- affected areas of pasture was 3.2 to 7.7 times greater than that observed during random

sampling across the grazed sward. Additional inorganic N was present as NH4(+), much of which had been nitrified by the time the profile was sampled in December at the onset of the drainage season. The small amount of residual inorganic N below the cut sward reflected the removal of at least 75% of the applied N in the harvested herbage. The cutting and conservation of herbage, and its subsequent use as feed, merely serves to delay the loss of nitrate that can occur after the disposal of slurry and farm-yield manure from winter-housed cattle. (Baker-IVI)
W85-02404

NONPOINT SOURCE LOADING OF TOXIC SUBSTANCES FROM DECOMPOSING CROP RESIDUE

Maryland Univ., College Park, MD, Dept. of Agronomy. S. Glenn.

Available from the National Technical Information Service, Springfield, VA 22161, as PB84-190198, Price codes: A02 in paper copy, A01 in microfiche. Maryland Water Resources Research Center Publication No. 76, August, 1983. 14 p., 5 Tab, 14 Ref. OWRT Project No. A-057-MD(1), Contract/Grant No. 14-34-0001-2122.

Descriptors: *Agricultural runoff, Runoff rates, Runoff volume, Cultivation, *Phytotoxicity, Phenols, *Decomposing organic matter, Decomposition, Agricultural watersheds, Maryland, *Path of pollutants, Water pollution sources.

Two adjacent, but separate watersheds were equipped to estimate total volume of runoff water and to collect an integrated water samples. One watershed was planted with corn (Zea mays L.) using no-tillage (NT) management and barley (Hordum vulgare L.) as a cover crop. The other watershed was planted with corn using conventional tillage (CT) management. Runoff water sampled between 1979 and 1983 were analyzed for phenolic acids and phytotoxicity to turnip (Brassica rapa L.). The volume of runoff water was reduced with NT management, but the concentration and total loading to phenolic acids were greater in runoff water from the NT watershed compared to that found in runoff water from the CT watershed. The greatest concentration of phenolic acids were found in runoff water from the NT watershed sampled on 6/18/79 (65.4 ppm, w/v). This sample inhibited radicle growth of turnip 32%. Ferulic acid, caffeic acid, P-hydroxybenzoic acid, o-hydroxyphenylacetic acid, and mandellic acid were isolated and identified from runoff samples.
W85-00075

PASTURE RUNOFF WATER QUALITY FROM APPLICATION OF INORGANIC AND ORGANIC NITROGEN SOURCES

Clemson Univ., SC. Dept of Agricultural Engineering. R.B. McLeod and R.O. Hegg.

Journal of Environmental Quality, Vol. 13, No. 1, p 122-126, 1984. 7 Fig., 4 Tab, 12 Ref.

Descriptors: *Agricultural runoff, *Water quality, *Nitrogen, Nitrogen compounds, Water pollution sources, Fertilization, Waste disposal, Municipal wastewater, Manure, Water pollution, Fertilizer, Ammonium nitrate.

After an organic waste has been applied to a soil, some of the waste may be transported by rainfall runoff, snowmelt, or irrigation runoff into surface waters. Surface runoff water quality from a fescue paster receiving surface application of organic wastes and commercial fertlizer was evaluated at Clemson University (Clemson, S.C.). Dairy manure, poultry manure, and municipal sludge were the organic wastes used in this experiment. Ammonium nitrate was the commercial fertilizer. The organic wastes and commercial fertilizer were applied at the rate of 112 kg N/ha to eight plots during four different periods. Due to an extremely dry year, runoff events were produced by irrigation. The runoff water was collected and samples were analyzed for pH, total P, total suspended solids, total Kjeldahl N, NH4-N, NO3-N, and chemical oxygen demand. The nutrient concentrations in surface runoff were more dependent on the number of rainfalls since application of the fertilizer than on the quantity of rainfall or runoff. The concentrations of potential pollutants from surface-applied organic wastes or commercial fertilizer were reduced by between 80 and 55% after two runoff events. The NO3-N concentration in the surface runoff from the plots receiving the commercial fertilizer exceeded the permissible public water supply standard during the first runoff event. The overall nutrient loss in the runoff was found to be minimal ($<$ 2.5% of total P). (Murphy-IVI)
W84-03944

PLANT NUTRIENT YIELDS IN RUNOFF FROM A MISSISSIPPI DELTA WATERSHED

Agricultural Research Service, Oxford, MS. L.L.McDowell, G.H. Willis, and C.E. Murphree.

Transactions of the ASAE, Vol. 27, No. 4, p. 1059-1066 and 1073, July/August, 1984. 12 Fig., 9 Tab, 30 Ref.

Descriptors: *Mississippi Delta, *Runoff, *Sediments, *Nutrients, Clay soils, Nitrogen, Phosphorus, Ammonium, Nitrate, Tillage, Erosion control, Agricultural runoff.

Plant nutrients and sediment concentrations in surface runoff from a 15.6-ha watershed, planted to continuous cotton (Gossypium hirsutum L.), were measured from July 1972 through June 1978 to determine the nutrient and sediment yields. The watershed, consisting of Sharkey silty clay soil (Vertic Haplaquepts), had been land-formed to a mean slope of 0.2%. The 6-yr average annual rainfall, runoff and sediment yields were 1355 mm, 550 mm and 16.3 t/ha, respectively. Nitrogen (N) fertilizer was applied at the rate of 171 kg N/ha-yr during calendar years 1972 through 1978. Phosphorus (P) fertilizer was not applied because cotton growing on this soil does not respond to P fertilization. The discharge-weighted ammonium-nitrogen (NH4-N), nitrate-nitrogen (NO3-N), and soluble P concentrations

were 0.15, 3.2, and 0.26 mg/L, respectively, for the study period. The 6-yr average soluble N (NH4-N plus NO3-N) and P yields were 18.7 and 1.4 kg/ha-yr, respectively, compared with sediment N and P yields of 31.0 and 18.3 kg/ha-yr. Thus, about 38 and 7% of the total (sum of solution and sediment) N and P yields were transported in solution; the remainder was transported by the sediments. Sediment and nutrient yields were much greater than expected from these flat lands. Reduced fall and winter tillage, which is gaining acceptance in the Delta, will probably help reduce sediment and associated nutrient yields, but improved erosion control practices are needed during the spring tillage period to significantly reduce sediment and chemical yields from these croplands. (Author's abstract)
W85-03397

POLLUTION POTENTIAL RANKING OF BARNYARDS FOR PRIORITY WATERSHED PLANNING

Wisconisn Univ.-Madison. Dept. of Soil Science. T.C. Daniel and R.M. Motschall.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-202358, Price codes: A02 in paper copy, A01 in microfiche. Water Resources Center Technical Report WIS WRC 83-02, Univ. of Wisconisn, Madison, 1983. 15 p., 4 Fig., 2 Tab, 14 Ref. OWRT A-093-WIS(1), 14-34-0001-0153

Descriptors: *Animal wastes, *Barn wastes, *Manure, *Water pollution prevention, *Watershed management, Agricultural watersheds, Dairy industry, Farms, Feedlot runoff, Feedlot wastes, *Phosphorus.

A barnyard ranking method using adjusted available P concentrations was developed so that pollution control funds can be allocated according to the 'worst first' approach. The ranking method was derived from soil data that was obtained from waterways and background locations near impact areas. Mean waterway available P concentrations ranged from 41 to 470 ppm. A distinct nutrient grandient exists in waterway soil with distance from barnyards so data obtained near the impact area are representative of waterway trends. Mean background available P concentrations ranged from 66 to 140 ppm. Background data indicate that excessive landspreading of manure occurred near barnyards. A critical management level (CML) was defined from background data collected near impact areas. The CML is a standard to establish a cutoff level between critical and noncritical sites. The proposed CML (150 ppm) is the best estimate based on available data.
W83-02915

QUANTITY AND QUALITY VARIATIONS IN SUBSURFACE DRAINAGE

Nevada Univ., Reno, NV, Div. of Plant, Soil and Water Science. J.C. Guitjens, P.S. Tsui, and D.F. Thran. Transactions of the ASAE, Vol. 27, No. 2, p.425-428, March-April, 1984. 9 Fig, 3 Tab, 7 Ref.

Descriptors: *Subsurface drainage, *Water quality, *Water supply, Wheat, Alfalfa, Irrigation, Dissolved solids, Flood irrigation, Sprinkler irrigation, Sodium, Chlorides, Turbidty, Suspended solids, Nitrogen.

Fifteen parallel drains, spaced at 37 m and servicing an overlying area of 180,000 sq m, were monitored for quality and quantity evaluation of subsurface drainage. Of interest were spatial and temporal variations in drainage and whether such variations were induced by changes in water management. Spring wheat was grown in 1979, winter wheat in 1980, and alfalfa in 1981. Irrigation methods included flooding and sprinkling. In the first two years TDS vs. EC, TDS vs. Na, and TDS vs. CI were statistically significant in simple regression tests. Mean annual values of all drains combined showed significant differences between 1979 and 1980 in the case of concentrations of CO3, turbidity, TSS, and Kjedlahl-N. Only TSS and Kjeldahl-N were significantly different for loading rates. Spatial variations were very pronounced; each parameter produced a different spatial pattern for annual mean values. Data from 1981 were used to demonstrate temporal variability. Management effects could not be separated from natural effects of the soil. (Author's abstract)
W85-01188

RESPONSE OF AGRICULTURAL SOILS TO ACID DEPOSITION

Arthur, M.F.; Wagner, C.K. (Battelle Columbus Labs., OH (USA)). Jul 1982. 142p. (CONF-8105185—). NTIS, PC A07/MF A01. Order No. DE82906474.

From EPRI workshop on response of agricultural soils to acid deposition; Columbus, OH, USA (12 May 1981).

Proceedings of the workshop, Response of Agricultural Soils to Acid Deposition, which was held May 12-13 1981, in Columbus, Ohio, and which evaluated the potential beneficial and harmful impacts of atmospheric acid deposition on agricultural soils are presented. Those issues requiring further research are also identified. Five working papers and a literature review prepared by soils specialists are included as is a summary of conclusions reached by the participants. Each of the five working papers has been abstracted and indexed individually for ERA/EDB. (JGB)

RUNOFF LOSSES OF NUTRIENTS AND SOIL FROM GROUND FALL FERTILIZED AFTER SOYBEAN HARVEST

Iowa State Univ., Ames, IA, Dept. of Agricultural Engineering. L. Baker and J.M. Laflen.
Transactions of the American Society of Agricultural Engineers, Vol. 26, No. 4, p. 1122-1127, July, August, 1983. 6 Tab, 13 Fig.

Descriptors: *Fertilizers, *Nutrients, *Water pollution sources, *Agricultural runoff, *Soil erosion, Soybeans, Tillage, Point-injection, Water quality control.

Plot measurements of soil and nutrient runoff concentrations and losses were made for two simulated rains in the fall after soybean harvest and fertilization (N, P, and K at 31, 35, and 80 kg/ha respectively). The five treatments were: fertilizer surface-applied, no incorporation; fertilizer point-injected into the soil; fertilizer incorporated by disking; and no fertilizer applied, no tillage. Chisel plowing reduced surface residue coverage from 82% (before tillage and the first rain to 48%; disking coverage to 31%. About half the residue buried by tillage was uncovered by the first rain. Sediment concentrations in runoff from the tillage plots were about three times higher than from the no-tillage plots. For rain 1 (111 mm), loosening the soil by tillage reduced runoff amounts, particularly from the chisel-plow treatment; for rain 2(72 mm), runoff from the disked treatment was about three times that from the other treatments. Total soil loss from the disk treatments was 2.3 T/ha, which was at least three times higher than any other treatment. Concentration of NH4-N, PO4-P, and K in runoff water and on sediment from treatments where fertilizer was incorporated by either point injection or tillage were at the same levels as from the unfertilized treatment. Chemical concentrations from the surface-application-without-incorporation treatment were significantly higher than from all other treatments, particularly for the first rain (e.g., NH4-N greater than 3 mg/L, PO4-P greater than 0.9 mg/L, and K greater than 18 mg/l). Total NH4-N, PO4-P, and K losses were also the greatest for the surface-applications-without-incorporation treatment, but were only 0.8, 0.4, and 5.9 kg/ha, respectively. On the basis of these results, fall fertilization would not be recommended because of water quality concerns. If fertilizer is applied, no tillage should be performed because of the potential for increased soil losses; but if tillage is performed, chisel plowing would be preferred to disking. When point-injection of liquid fertilizers becomes feasible on a large scale, its advantage of nutrient incorporation without residue incorporation will warrant its recommendation. (Author's abstract)
W84-04457

RUNOFF WATER QUALITY FROM DIARY PASTURES IN THE PIEDMONT REGION

Clemson Univ., SC. Dept. of Agricultural Engineering.
L.E. Reese, R.O. Hegg, and R.E. Gantt.
Transactions of the ASAE, Vol 25, No 3, p. 697-701, May/June, 1982. 8 Fig., 6 Tab, 10 Ref.

Descriptors: *Water quality, Rainfall-runoff relationships, Rainfall, *Runoff, *Water pollution sources, Manure, Fertilizers, Bacteria, Fecal coliform, Coliforms, Slope, Vegetation, *South Carolina, *Piedmont Region.

Background levels on the quantity and quality of surface runoff from pasture lands of the Piedmont Region were determined. Runoff water quality after surface application of dairy wastes to pasturelands was determined based on recommended nitrogen application rates. Eight 0.012 ha boardered pasture plots at Clemson dairy farm were used to collect, measure and sample natural and simulated surface runoff events. The vegetative cover was primarily tall Kentucky 31 fescue and some ladino clover. The plot was of Cecil clay soil type with a 3-5% slope. The background rainfall events which produced runoff indicated a mean runoff producing rainfall of 3.81 cm, a mean runoff of 0.69 cm, and a mean percent runoff of 22.2%. All background concentrations are rather low as expected from an unfertilized pasture and would offer little pollution potential with the exception of coliform levels. Total coliform and fecal coliform bacteria levels on the unfertilized pasture were higher than allowed for public water supply standards. Nitrate-nitrogen levels were all well below permissible standards of 10mg/liter. Surface application of dairy manure slurry produced higher initial runoff concentrations of total kjeldahl nitrogen (TKN), phosphate-phosphorus, chemical oxygen demand, and total solids compared to counterpart dry manure applications. After initial runoff periods, surface applications of dry dairy waste produced slightly higher runoff concentrations of TKN, phosphate-phosphorus, COD and total solids compared to counterpart slurry applications. Following four runoff events, TKN, COD, and TS runoff was at a low stable concentration. Seven runoff events lowered phosphate phosphorus to stable concentrations. (Baker-FRC)
W83-00870

SOIL AND NUTRIENT RUNOFF LOSSES WITH IN-ROW CHISEL PLANTED SOYBEANS

Agricultural Research Service, Watkinsville, GA. G.W. Langdale, H.F. Perkins, A.P. Barnett, J.C. Reardon, and R.L. Wilson, Jr.
Journal of Soil and Water Conservation, p. 297-301, May-June, 1983. 1 Fig., 5 Tab, 20 Ref.

Descriptors: *Soil erosion, *Nutrients, *Runoff, *Soybeans, *Conservation tillage, Agricultural runoff, Crop residues, Nutrient losses, Mulches, Rye.

Coulter, in-row chiseling 20 centimeters deep in rye stubble effectively controlled runoff (less than or equal to 13%) on rainulator plots (10.7- and 21.4-meter slope lengths) with a 7% slope until water content in the topsoil approached 14.2% (about 0.1-bar suction). In-row chiseling and soil cover collectively reduced soil losses during rainulator runs to less than 0.5 metric ton per hectare on both slope lengths. Increased slope length led to increased runoff, event with low soil water content during soybean canopy development. Removing crop residue and destroying the chisel slot with complete tillage caused soil losses exceeding 40 metric tons per hectare. Runoff-weighted nutrient losses related positively to soil losses. Increased slope length consistently increased nutrient losses during all tillage-soil cover sequences. Most nutrient loss variation was accounted for by treating soil loss as an independent variable during the rye mulch cover period. Phosphorus losses were correlated better to soil losses among tillage-soil cover sequences than to the cations. Coulter, in-row, chisel-planted soybeans

through rye residues following winter-spring cattle grazing of rye effectively controlled runoff as well as soil loss and some nutrient losses. (Murphy-IVI)
W84-03062

SOIL AND WATER LOSSES AS AFFECTED BY TILLAGE AND MANURE APPLICATION

Wisconsin Univ. Madison, WI, Dept. of Soil Science. D.H. Mueller, R.C. Wendt, and T.C. Daniel.

Soil Science Society of America Journal, Vol. 48, p. 896-900, 1984. 1 Fig., 4 Tab, 26 Ref. EPA grant G001359-01.

Descriptors: *Tillage, *Water loss, *Soil erosion, *Manure, Rainfall, Runoff, Best management practices, Crop residue.

Little data are available on conservation tillage under field conditions characteristic of a dairy operation. Thus, simulated rainfall was used to compare soil and water losses among conventional, chisel, and no-till systems for corn both with and without surface-applied manure prior to tillage. Rainfall was applied at several times during the growing season of 1978 and 1979. A portion of the previous year's crops residue was removed in 1978 and all the residue was left in 1979. A tillage x date interaction was observed for runoff losses in both years of the experiment. Significantly lower runoff occurred for the conventional and chisel systems relative to the no-till system immediately after planting. At late sampling periods, runoff significantly increased for the conventional system and runoff losses approached that from no-till. In contrast, lower runoff losses occurred for the chisel system relative to the other tillage systems. This was most apparent in 1979 when more residue was partially incorporated or left on the soil surface. Surface spread manure decreased runoff for all tillage treatments at the September 1978 sampling period and at both sampling periods in 1979. The results indicated the greatest response with the chisel system. In 1978 and 1979, a tillage x manure interaction was observed for the soil loss. In 1978, little difference in soil loss was observed among unmanured tillage treatments. However, the application of manure reduced soil losses for chisel and no-till systems relative to the conventional system. In 1979, soil losses were lower from unmanured chisel and unmanured no-till treatments than from the unmanured conventional treatment. Soil losses were significantly lower from the manured chisel treatment than all other treatments. (Author's abstract)
W85-02323

SOIL CONSERVATION AND WATER QUALITY IMPROVEMENT: WHAT FARMERS THINK

Georgia Univ., Athens, GA, Dept. of Agricultural Economics. L.A. Christensen and P.E. Norris.

Journal of Soil and Water Conservation, Vol. 38, No. 1, p. 15-20, January-February, 1983. 40 Ref.

Descriptors: *Soil conservation, *Water quality, *Farming, Public opinion, Government supports, Erosion control, Soil erosion.

A review is offered of farmers' attitudes about the control of nonpoint pollution through soil conservation and other measures. While generally believing that soil erosion and water quality degradation are problems, farmers hesitate to admit that there is any relationship between their land and the national erosion problem. Farmers may be hesitant to recognize the problems and install conservation practices because of limited knowledge. The perceived effectiveness of a conservation practice will greatly influence a farmer's choice of a practice once he decides to implement a conservation program. Differing perceptions of the effectiveness of the conservation practices can be attributed to variations in both information about and experience with the practice. Perceptions of risks related to yields and income levels also influence a farmer's decision. Perceptions of benefits may also prevent farmers from initiating conservation programs. Apparently there is some question about the profitability of using conservation practices. Attitudes toward government involvement, personal characteristics, institutional characteristics, physical characteristics, and policy implications each in their own way influence the farmer's acceptance of soil conservation measures. (Baker-FRC)
W83-03161

STOCHASTIC MODELS IN AGRICULTURAL WATERSHEDS

Utah State Univ., Logan. Dept of Civil and Environmental Engineering. C.J. Duffy, L.W. Gelhar, and P.J. Wierenga.

Journal of Hydrology, Vol. 69, No. 1-4, p. 145-162, February, 1984, 7 Fig., 1 Tab, 20 Ref.

Descriptors: *Stochastic models, *Agricultural watersheds, Drainage systems, Deep percolation, Soil moisture, Irrigation models, Drainage models, Recharge, Rio Grande Valley, New Mexico.

Recent developments in stochastic time-series methods in water resources have demonstrated that a stochastic approach is often useful for characterizing complex natural processes. A stochastic time-series approach using spectral analysis theory is developed and applied to drainage analysis of an agricultural watershed, Rio Grande Valley, New Mexico, U.S.A. The spectral theory demonstrates that a linear reservoir model is a suitable approximation to the Dupuit aquifer over a wide range of frequencies. A first-order perturbation of the variables allows the system parameters to be evaluated from both the stochastic solution of the fluctuating or zero-mean process, and the temporal-mean or steady-state solution. Deep percolation is estimated by first assuming a "no storage" situation in which recharge is a constant fraction (leaching fraction) of applied water. A second approach to deep percolation incorporates a soil-moisture reservoir to simulate storage in the soil zone. The equations developed are useful for characterizing drainage systems which exhibit a statistically stationary response to rainfall and/or irrigation. (Murphy-IVI)
W84-03780

STRAW RESIDUE TO CONTROL FURROW EROSION ON SLOPING, IRRIGATED CROPLAND

Agricultural Research Service, Kimberly, ID. Snake River Conservation Research Center. R.D. Berg.
Journal of Soil and Water Conservation, Vol. 39, No. 1, p. 58-60, January-February, 1984, 1 Fig., 4 Tab, 4 Ref.

Descriptors: *Erosion control, *Farm management, *Straw, *Idaho, *Irrigation, Crop yield, Sedimentation, Silt, Soil conservation.

Many fields in southern Idaho have a relatively flat slope at the upper end and a steep slope toward the middle or lower end of the field. During irrigation, flow velocity increases on the steeper sloping sections of furrows, and soil erosion increases greatly. Small amounts of straw placed uniformly in steeply sloping portions of irrigation furrows reduced soil erosion and sedimentation on three fields with an erodible silt loam soil. Erosion was eliminated during the first irrigation on two fields in the straw-treated plots and markedly reduced during subsequent irrigations on these plots and on the third field. The reduction ranged from 30 to 100% in a straw-treated furrows compared to furrows without straw. Straw treatment also increased infiltration and lateral water movement significantly, and crop yields rose 7 to 16%. Placing straw in the furrows below the critical-slope areas resulted in the trapping of too much sediment. Furrows, filled with sediment, resulting in inadequate irrigation of downslope portions of the field. (Baker-IVI)
W84-03867

SUBSOIL CHARACTERISTICS INFLUENCE HYDROLOGIC RESPONSE TO NO-TILLAGE

Agricultural Research Service, Coshocton, OH. W.M. Edwards and C.R. Amerman.
Transactions of the ASAE, Vol. 27, No. 4, p. 1055-1058, July/August, 1984. 4 Fig., 2 Tab, 15 Ref.

Descriptors: *No-tillage, *Tillage, *Subsoil, *Soil types, *Hydrologic response, Runoff, Agricultural hydrology, Drainage, Corn, Land management, Water conservation.

Runoff was measured from two watersheds having similar top-soils. The subsoil of one watershed contained 20% clay with 40 to 60% sandstone fragments and was well-drained. Subsoil in the other watershed had < 15% coarse fragments with up to 40% clay content, which restricted drainage through the profile. In the 7 year that corn was grown with conventional tillage practices, runoff from summer storms was high and similar for both watersheds. Dormant season runoff from the watershed with the heavy subsoil was much greater than that from the well-drained one. With 5 year of continuous no-tillage corn production, summer runoff was nearly eliminated from both watersheds. Dormant season runoff, however, was not affected by tillage practice. Therefore, the effect of the no-tillage treatment on reducing total annual runoff was greater on the well-drained soil than it was where internal drainage was restricted. (Author's abstract)
W85-03396

SYSTEMS APPROACH FOR AGRICULTURAL LAND MANAGEMENT AND WATER QUALITY CONTROL

Virginia Polytechnic Inst. and State Univ., Blacksburg, VA. S.M. Trapanese, M.D. Smolen, and T.M. Younos.
Transactions of the ASAE, Vol. 27, No. 3, p. 817-821, May/June, 1984. 5 Fig., 3 Tab, 17 Ref.

Descriptors: *Land management, *Erosion control, *Crop production, *Cultivation, *Model studies, Cost analysis, Agricultural runoff, Water pollution control, Virginia, Corn.

The Finite Element Storm Hydrograph Model (FESHM) (B.B. Ross, M.L. Wolfe, V.O. Shanholtz, M.D. Smolen, and D.N. Contractor, 1982. Model for Simulating Runoff and Erosion in Ungaged Watersheds, Virginia Water Resources Research Center, Blacksburg, VA. Bulletin 130) was used to simulate the impact of alternative land management strategies on the average annual sediment yield in Cunningham Creek watershed in the southeastern piedmont section of Virginia. The sediment yield output from the hydrologic simulation was used to estimate activity coefficients for a linear programming model to identify the management strategy with the least sediment yield at acceptable farm income levels. The analysis showed that substitution of conservation management practices could be highly cost-effective if they produce profit levels near those of conventional, more erosive practices. In one example, 50% reduction of sediment yield could have been obtained with no loss of income by substituting no till corn for conventional tilage corn; a government income subsidy should not have been necessary to improve water quality because a more profitable, less erosive, alternative was available. In another example, where the conventional practice allowed a slightly higher profit, but substantially higher erosivity, government cost sharing or income subsidy should be a more cost-effective approach. (Collier-IVI)
W85-03390

TERRACED PASTURE FOR DISPOSAL OF DAIRY YARD RUNOFF

Clemson Univ., SC. Dept. of Agricultural Engineering. R. O. Hegg, C.L. Barth, V.L. Quisenberry, and W. H. Livingston.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-191940, Price codes: A04 in paper copy, A01 in microfiche. Report No. 99, 1982, 42 p., 5 Fig., 6 Tables, 18 Ref. OWRT A-045-SC(1), 14-34-0001-0143.

Descriptors: Runoff, *Animal wastes, *Agricultural wastes, *Agricultural runoff, Rainfall-runoff relationships, Nitrogen, Phosphorus, Pastures, *South Carolina, Animal waste treatment, *Land application, Waste disposal.

An alternative system of handling and disposing of milking barn wastewater and feedlot runoff water was evaluated for three years. This system was established on a 50-cow

dairy farm in South Carolina and consisted of utilizing a pasture areas downslope from a dairy to infiltrate and filter the liquid, nutrients and solids from the milking barn and the dairy feedlot runoff water. The pasture was modified by the addition of a spreader terrace and three level terraces to distribute the runoff water. Wastewater discharged from the milking barn typically infiltrated the soil before reaching the terrace system. Several of the small rainstorms produced runoff from the dairy feedlot which was completely infiltrated by the terraced pasture. The concentration of the runoff water leaving the dairy feedlot was reduced by the time it left the terraced pasture, for rains which produced runoff at both weirs, by an average percentage of: NH sub 3-N, 87; TKN, 88; PO sub 4-P, 79; COD, 83; TS, 50; total coliform, 79; and fecal coliform, 90. The mass of nutrients was reduced by an average of: NO sub 3-N, 75; NH sub 3-N, 69; TKN, 76; PO sub 4; 68; COD, 91 and TS, 14 all as percentages, including rains that produced runoff from the feedlot but not necessarily from the terraced pasture. The system performed were satisfactorily. The operator did not have to spend any time or money on the disposal system after the initial preparation of the terraced pasture.
W83-02741

THE COSTS AND BENEFITS OF SOIL EROSION CONTROL IN THE NORTH LAKE CHICOT WATERSHED

Arkansas Univ., Fayetteville, AR, Dept. of Agricultural Economics and Rural Sociology. R.N. Shulstad, C.T. Osborn, and A.D. McQueen.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-222208, Price codes: A03 in paper copy, A01 in microfiche. Water Resources Research Center Publication No 95, Univ. of Arkansas, Fayetteville, March 1983. 49 p., 1 Fig., 4 Tab, 8 Ref. OWRT A-056-ARK(2), 14-34-0001-2104

Descriptors: *Arkansas, *Soil erosion, *Watershed management, Farm management, *Soil conservation, *Lake basins, Surface water, *Economic feasibility, *Cost-benefit analysis, *Recreation demand, Lake Chicot.

Lake Chicot is divided by a leveee into two basins, the high quality northern basin and the extremely polluted southern basin. Water quality in the northern basin of Lake Chicot is diminishing due to soil erosion. Costs for alternative control programs for the seventeen farm, 11,470 acre northern watershed were estimated. Twenty-nine combinations of rotations and best management practices were evaluated. Soil loss can be reduced almost 25% from 4.2 tons per acre to 3.2 tons per acre, while increasing net returns to farmers from $83.94 per acre to $107.28 per acre by altering present cropping patterns. A prohibition on fall plowing would result in an average net return of $106.28 per acre and reduce average soil loss to 2.9 tons per acre. An average soil loss restriction would be the most cost-effective policy, exclusive of administrative costs. Benefits of erosion control were estimated by the difference between the value of recreational participation on the northern basin and the value for the southern basin. Controls programs were highly cost-effective.
W83-03331

THE EFFECTS OF AGRICULTURAL LAND MANAGEMENT OF FLUVIAL TRANSPORT OF PARTICULATE AND DISSOLVED PHOSPHATE

Ohio State Univ., Columbus, OH, Dept. of Agronomy. T.J. Logan. Hydrobiologia, Vol. 92, p.519-530, July, 1982. 6 Fig., 50 Ref.

Descriptors: *Phosphates, *Lake sediments, *Particulates, Dissolved solids, Fate of pollutants, Water pollution sources, Water pollution control, Adsorption, Desorption.

The bulk of the phosphate load to lakes is from land drainage, and includes varying proportions of sediment-bound P and dissolved P. P sources which may enter a lake through land drainage include native soil phosphate, fertilizer P, and livestock and municipal wastes. Sediment-bound phosphate includes organic and inorganic forms, but the inorganic fraction contains most of the P that can be released into water. The non-apatite inorganic P (NAIP) fraction of sediment-bound phosphate varies considerably with geochemistry and anthropogenic additions. A small fraction of the NAIP is sufficiently labile to desorb into water, and this release can be described by dissolution or absorption/desorption mechanisms. Agricultural practices, such as phosphate fertility management and conservation tillage, which affect the levels of phosphate and sediment leaving the land, will determine the partition of sediment-bound P and dissolved P in water draining into lakes. The response of algae to dissolved P must be different than to particulate P sources, which may settle out of the photic zone before they can be completely utilized. Phosphorus control strategies for deep lakes, with little sediment resuspension for lake overturn, must emphasize dissolved P sources more than for shallower lakes, where sediments are continuously resuspended and lake overturn can bring P released from bottom sediments to the surface.
(Moore-IVI)
W85-02095

TILLAGE AND CULTURAL MANAGEMENT OF IRRIGATED POTATOES

Iowa State Univ., Ames, IA, Dept. of Agronomy. D.R. Buxton, and J.C. Zalewski
Agronomy Journal, Vol. 75, No. 2, p. 219-225, March-April, 1983. 4 Fig., 5 Tab, 23 Ref.

Descriptors: *Tillage, *Cultural management, *Irrigation, *Potatoes, Soil compaction, Irrigation effects, Soil organic matter, Soil texture, Infiltration rate, Soil-water-plant relationships.

Many intensively row-cropped, irrigated soils are compacted and have slow water infiltration rates. Evaluating the relationship among soil compaction, water infiltration rates,

and potato (Solanum tuberosum L.) yield and quality will help determine the influence of tillage and other practices on soil compaction, water infiltration rates, and potato response. Twenty-two commercial, irrigated potato fields were monitored and several tillage practices evaluated on soils from seven great groups. Soil compaction was evaluated by measuring penetrometer resistance. Although penetrometer resistance and water infiltration rates showed a large amount of variation in the 22 fields, they were not significantly correlated with each other. The correlation coefficient between penetrometer resistance 0.2 m below furrows and tuber yield was -0.38. Water infiltration rate was not associated with tuber yield nor quality. In the 18 fields with less than 600 g/kg sand, soil texture had little association with water infiltration rates, however, soil organic matter greater than 12 g/kg was positively associated with water infiltration rates. In the 22 fields, number of years between successive potato crops accounted for 33% of the variation in tuber yield with greatest fields when at least 4 years occurred between potato crops. In replicated tillage experiments, chiseling reduced penetrometer resistance to a deeper depth than moldboard plowing. Chiseling did not result in greater water infiltration rates, tuber yield, nor tuber quality than plowing. Chiseling and plowing in combination showed no advantage over either practice alone. Additionally, chiseling bed centers showed no yield advantage over an unchiseled check in fields that were previously plowed even though penetrometer resistance was reduced by chiseling. This study indicates that with proper irrigation management some deep tillage operations can be eliminated by many growers. (Murphy-IVI)
W84-03242

TILLAGE SYSTEM AND RESIDUE COVER EFFECTS ON INFILTRATION IN NORTHWESTERN CORN BELT SOILS

Agricultural Research Service, Morris, MN. M.J. Lindstron, W.B. Voorhees, and C.A. Onstad.
Journal of Soil and Water Conservation, Vol. 39, No. 1, p. 64-68, January-February, 1984. 4 Fig., 2 Tab, 19 Ref.

Descriptors: *Tillage, *Residue cover, *Infiltration, Rainfall-runoff relationships, Agricultural runoff, Runoff rates, Runoff volume, Soil physical properties, Hydraulic conductivity, Rainfall energy.

Some reports indicate that tillage systems leaving residue on the soil surface will reduce runoff and erosion. Other reports, however, indicate that surface residue does not always reduce runoff, particularly in no-till systems. The conflict in these reports indicates that other factors, in combination with surface residue, must influence infiltration rate and runoff potential. Simulated rainfall trails were conducted in wheel-tracked and nonwheel-tracked interrows for conventional, reduced, and no-till cropping systems immediately after planting during the first and tenth years of continuous corn. Results showed that (a) tractor wheel-traced interrows were vulnerable to runoff regardless of tillage system and (b) infiltration declined after runoff started. Runoff occurred quickly on the no till, nonwheel-tracked interrow, indicating the presence of some infiltration restricting factor(s). Bulk density, penetrometer resistance, saturated hydraulic conductivity, and pore-size distribution were measured during the third crop year of continuous corn to determine soil physical properties that developed with tillage systems and the effect these properties had on infiltration. The no-till treatment-modified in this trial by cultivation during the previous growing season to form ridges — was characterized by a higher bulk density, greater penetrometer resistance, reduced saturated hydraulic conductivity, and a lower volume of macropores. The no-till treatment exhibited reduced infiltration. Surface crop residue effectively increased the rainfall energy required to start runoff under the reduced tillage system, but residue had no effect when soil surface conditions (no-till and wheel-tracked interrows) had developed that restricted water movement into the soil. (Murphy-IVI)
W84-03868

TILLAGE, RESIDUE AND EROSION ON MODERATELY SLOPING SOILS

Nebraska Univ. Lincoln, NE, Dept. of Agricultural Engineering, E.C. Dickey, D.P. Shelton, P.J. Jasa, and T.R. Peterson.
Transactions of the ASAE, Vol. 27, No. 4, p. 1093-1099, July/August, 1984. 7 Fig., 2 Tab, 11 Ref.

Descriptors: *Tillage, *Residue, *Soil erosion, Silt loam soil, Silty clay loam, Runoff, Sediment, Land management, Erosion.

Soil loss from various tillage systems used on a silty clay loam having a 5% slope and a silt loam soil having a 10% slope was evaluated using rainfall simulation techniques. The moldboard plow treatment always had the greatest soil loss while the no-till treatment had the least. Tillage treatments leaving 20% or more of the soil surface covered with the residue reduced soil erosion by at least 50% of that which occurred from a mold-board plow system. No-till tended to have the lowest cumulative runoff. Because the runoff rate tended to be the same for all tillage treatments, differences in erosion were primarily due to differences in sediment concentration in the runoff. The sediment concentration was always highest for the no-till treatments. The soil loss and sediment concentration data were highly correlated with the percent of soil surface covered with residue. For both the 5 and 10% slopes, tillage systems leaving 20% or more of the soil surface covered with residues reduced soil loss by at least 50% of that which occurred from cleanly tilled, residue free conditions. (Collier-IVI)
W85-03402

USING EPA'S COMPUTERIZED DATA BASE (STORED TO ANALYZE FOR AGRICULTURAL WATER PHOSPHATES

Virginia State Water Control Board, Richmond, VA, Bureau of Water Control Management. J.C. Reardon, L.D.

Hanson, and J. Randolph.
Journal of Environmental Quality, Vol. 11, No. 3, p. 427-432, 1982. 2 Fig., 3 Tab, 18 Ref.

Descriptors: *Agricultural runoff, *Nonpoint pollution sources, *Farm management, Fate of pollutants, Water pollution sources, Phosphates, Nitrates, Nitrites, Coliforms, *STORET, Agricultural wastes, Animal wastes, Cultivation, Runoff, Little Bennett Creek, *Maryland, Farm wastes, Data storage and retrieval, Water quality control.

The computer data base STORET was used to retrieve stream water quality data for a 9-year period for the upper Little Bennett Creek watershed, Maryland. This agricultural watershed contains many large dairy farms which have waste management and storage facilities. During the study period the use of no-till and minimum-tillage corn practices increased by about 90%, and several operators improved their waste control facilities. STORET data from 4 sampling stations were used to relate concentrations of total phosphate, fecal coliforms, and nitrate-nitrite-N data to time. Linear regressions indicated that total phosphate and fecal coliforms decreased with time. Total phosphate data from all sampling stations showed a significant inverse relationship between concentration and time. Only the furthest-upstream station produced a significant relationship between fecal coliform concentrations and time. Nitrate-nitrite regression equations were not significant at any station. Use of the computerized information allowed analysis of data at about one-tenth the cost of a program requiring sampling and laboratory analysis. (Cassar-FRC)
W83-03895

WATER QUALITY CONSEQUENCES OF CONSERVATION TILLAGE

Iowa State Univ., Ames, IA, J.L. Baker and J.M. Laflen.
Journal of Soil and Water Conservation, Vol. 38, No. 3, p. 186-193, May-June, 1983, 4 Tab, 53 Ref.

Descriptors: *Water quality, *Water pollution sources, *Conservation tillage, Tillage, Erosion control, Soil conservation, Farm management, Vegetation, Agriculture, Runoff, Agricultural chemicals, Pesticides, Fertilizers.

Conservation tillage, which leaves some of all of the residue from the previous crop on the soil surface, effectively protects the soil against erosion. However, in order to maintain crop residues on th soil surface the use of fertilizers and pesticides is somewhat limited, affecting chemical concentrations and losses in surface water and sediment. Crop residue on the soil surface reduces runoff from all storms and eliminates runoff from most small storms. The slight to moderate reduction in runoff expected with conservation tillage systems will not alone have large impacts on the quality of receiving waters relative to chemicals lost in surface runoff. Of more importance in improving water quality is the soil conservation potential of conservation tillage and its impact on chemical losses with sediment. What impact conservation tillage has on chemical concentrations in runoff relates to the placement of agricultural chemicals during application and to the impact of conservation tillage on infiltration and runoff, particularly during the first storm after application, when most soluble losses occur. (Baker-IVI)
W84-03060

WATERSHED RESPONSES TO CONSERVATION MEASURES

Central Soil and Water Conservation Research and Training Inst., Dehra Dun (India), G. Sastry and V.V.D. Narayana.
Journal of Irrigation and Drainage Engineering, Vol. 110, No. 1, p. 14-21, March, 1984; 3 Fig., 2 Tab, 6 Ref.

Descriptors: *Water conservation, *Watershed management, *Doon Valley, *India, Forest watersheds, Agricultural watersheds, Runoff, Soil conservation, Check dams, Soil loss, Land use, Grazing.

In Doon Valley, India, when a natural forest watershed open to grazing is deforested and cultivated, volume and peak rates of runoff were higher by 15% and 72%, respectively. When the agricultural watershed is treated with soil and water conservation measures (construction of small field levees or bunds), the peak rate and volume of runoff are reduced by 86% and 62%, respectively, of the corresponding values when it was a natural forest watershed and the corresponding reduction in soil loss was 94%. When another comparable natural forest watershed is provided with brushwood check dams at appropriate locations, although no appreciable reduction in peak rate of runoff was observed, soil loss was reduced by 54%. (Author's abstract)
W84-04090

WHAT IS CONSERVATION TILLAGE?

Purdue Univ., Lafayette, IN. Dept of Agronomy. J.V. Mannering and C.R. Fenster.
Journal of Soil and Water Conservation, Vol. 38, No. 3, p. 140-143, May-June, 1983, 1 Fig., 5 Ref.

Descriptors: *Erosion control, *Soil conservation, Conservation tillage, Farming, Farm practices, Farm management, Tillage, Planning.

The suggestion is made that conservation tillage be used as an umbrella term, and that all tillage practices that conserve soil and water be listed under that term. Forms of row crop tillage include narrow strip tillage, no-tillage, strip rotary tillage, ridge planting, till-planting, full-width no-plow tillage, fall or spring chiseling, fall-spring disking, full-width plow tillage discussed include stirring and mixing machine tilling and stubble-mulch farming. People discussing conservation tillage are really talking about a system of farming. Equipment needs must be approached as a system based on soil and climatological conditions. The

system must adequately control soil erosion, conserve moisture, and accommodate the crops grown. Weed, disease and insect control chemicals must be better understood. The fertility needs of crops grown with conservation tillage systems must be met efficiently. How conservation tillage affects labor and energy demands must be learned. (Baker-IVI)
W84-03058

A DECISION MODEL TO PREDICT SEDIMENT YIELD FROM FOREST PRACTICES

National Forests in North Carolina, Asheville, NC, R. G. Burns and J. D. Hewlett.
Water Resources Bulletin, Vol. 19, No. 1, p. 9-14, February, 1983. 3 Fig., 1 Tab, 11 Ref.

Descriptors: *Sediment yield, *Model studies, *Forest management, Mathematical equations, Estimating equations, Decision making, Erosion, Erosion control, Forestry, *Georgia. Forest managers need to predict sediment yield to perennial streams following various forest land operations in order to choose among best management practices. The universal soil loss equation (USLE) is not directly applicable to forest operations due to the heterogeneous soil surface conditions left by harvesting, site preparation, and planting. A sediment hazard index is proposed, to be based on the amount of exposed mineral soil and its proximity to streams. The model offered includes rainfall erosivity, soil erodibility, and average land slope, together with the index W. A paired watershed experiment in the central Georgia Piedmont was used to estimate parameters in the model. The experimental basis, 80 acres, was clearcut, drum roller chopped twice, and planted by machine. The standard error of estimate of the sediment yield was computed to be about 50 lb/ac per sampling period for four months. Use of Williams' erosivity index reduced the standard error to 33 lb/ac. It is suggested that the equations presented predict conservatively high for the normal range of expected rainfalls, but probably low under extreme rainfall. (Baker-FRC)
W84-00099

ALTERATION OF STREAMFLOW CHARACTERISTICS FOLLOWING ROAD CONSTRUCTION IN NORTH CENTRAL IDAHO

Intermountain Forest and Range Experiment Station, Moscow, ID. Forestry Sciences Lab. J. G. King and L. C. Tennyson. Water Resources Research, Vol. 20, No. 8, p. 1159-1163, August, 1984. 1 Fig., 2 Tab, 11 Ref.

Descriptors: *Streamflow, *Idaho, *Forest management, *Access roads, *Road, construction, Forest watersheds, Watersheds, Watershed management, Maximum flow, Minimum flow, Water yield.

Effects of logging access roads on seven streamflow variables were monitored on six forested headwater watersheds in north central Idaho. The streamflow variables were: annual maximum streamflow; date of maximum streamflow; annual minimum streamflow; annual water yield; and streamflow equaled or exceeded 5% of the year, 25% of the year, and 75% of the year. The watersheds, ranging in area from 28.3 to 147.7 ha, had less than 5% of their area in roads. Two statistically significant (alpha = 0.05) changes occurred following road construction: an increase in the 25% exceedance flows in one watershed and a decrease in the 5% exceedance flows in another watershed. No significant changes were detected in other flow parameters on any of the watersheds. The results indicate that the hydrologic behavior of small forested watersheds may be altered when only a small area is disturbed by roads. (Author's abstract)
W85-02372

ASSESSMENT OF STORMFLOW AND WATER QUALITY FROM UNDISTURBED AND SITE PREPARED FOREST LAND IN EAST TEXAS

Texas A and M Univ., College Station, TX, Water Resources Inst. M. G. DeHaven, W. H. Blackburn, J. L. Nieber, W. W. Crawley, and A. T. Weichert.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-219816, Price codes: A07 in paper copy, A01 in microfiche. Completion Report No. 122, January 1983. 125 p., 46 Tab, 40 Ref., 2 Append. OWRT A-049-TEX(1), 14-34-0001-0146,1146,2146.

Descriptors: Sediments, Nutrients, Nonpoint pollution sources, *Forest practices, Water quality, Watersheds, Biomass, Clearcutting, Shearing, Windrowing, *Texas, Stormflow, *Forest watersheds, Lumbering.

Nine small forested watersheds were instrumented in 1979 to determine the effect of intensive forest management practices on water quantity and quality. During 1981, the first year after treatment, stormflow volumes, sediment and nutrient losses increased with the intensity of the site disturbance. Sites sheared produced the greatest amount of stormflow, sediment and nitrate losses, followed by chopped and the undisturbed watersheds. Stormflow volumes, sediment and nitrate decreased on the sheared and chopped watersheds substantially the second year following treatment. The rapid vegetation and reduction in exposed mineral soil that occurred on both sheared and chopped treatments during 1982, resulted in a decrease in runoff and sediment and nutrient losses. Limiting shearing and windrowing activities to the more gentle slopes will reduce first year erosion and prevent increases in sediment and nutrient losses. Roller chopping on the other hand, appears to cause only minor changes to water yield and quality on slopes of up to 25%.
W83-03277

CHARACTERISTICS OF SEDIMENT AND ORGANIC CARBON EXPORT FROM PRISTINE BOREAL FOREST WATERSHEDS

Woods Hole Oceanographic Institution, MA R. J. Naiman.
Canadian Journal of Fisheries and Aquatic Sciences, Vol. 39, No. 12, p. 1699-1718, December, 1982. 14 Fig., 6 Tab, 46 Ref.

Descriptors: *Organic matter, *Forest watersheds, *Sediment transport, Organic carbon, Rivers, Stream order, Particulate matter, Quebec, Suspended load.

Sediment and organic matter were measured in 1979-81 in five pristine Quebec streams: First Choice Creek (1st order), Beaver Creek (2nd order), Muskrat River (5th order, Matamek River (6th order), and Moisie River (9th order). During the 2-month spring freshet 71-92% of the annual sediment load and 59-65% of the annual particulate organic matter (POM) load are exported. Sediment yield varies from 1.5 to 7.6 g per sq m per year; POM export, from 1.0 to 6.7 g ash free dry weight per sq m per year; and dissolved organic carbon export, from 3.1 to 48.4 g C per sq m per year. Apparently carbon is rapidly loaded between first and second order streams, after which biological and physical processing increases. POM export/input ratios were 2.5 in the first order stream, 8.3 in the second order stream, and 0.3-0.6 in the higher order streams. In the largest watershed, Moisie River, the C export was 4.7 g C per sq m per year; coarse particulate organic matter, negligible; and oxidation of suspended load, < 0.5% per day. Concentrations of organic matter are relatively unaffected by summer storms, diel variations, and depth of sample in the water column. However, in streams processing and retention devices do exert considerable control over the quantity and nature of suspended organic matter. (Cassar-FRC)
W83-04109

EFFECT OF CLEAR-CUT SILVICULTURE ON DISSOLVED ION EXPORT AND WATER YIELD IN THE PIEDMONT

Georgia Univ., Athens, GA, School of Forest Resources.
J. D. Hewlett, H. E. Post, and R. Doss.
Water Resources Research, Vol. 20, No. 7. p. 1030-1038, July, 1984. 5 Fig., 5 Tab, 31 Ref.

Descriptors: *Clear-cutting, *Solute transport, *Water yield, *Piedmont, *Georgia, Water quality, Water pollution sources, Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sodium.

A paired watershed experiment on Putnam County, Georgia, was carried out from 1973 to 1980 to determine the effects of a typical southern clear-cut operation on water quality, timing, and yield. This report shows that increases in monthly exports of dissolved N, P, K, Ca, Mg, Na, TKN, and total electrolytes were short-lived and less than 0.5 kg/ha/month and may therefore be considered minor for practical purposes. Stream water concentrations were mostly diluted by clear-cutting, but a monthly water yield increase of 1 to 2 cm flushed an extra 0.15 kg/ha/month of nitrate-nitrogen from the basin during a 2-year period following harvest. Twenty surrounding forested basins (7 to 165 ha in area) were sampled monthly for 1 year, showing that the experimental pair was representative of the general levels of dissolved ions in forested Piedmont streams. Results suggest that clear-cut silviculture in this region will neither reduce soil fertility by flushing ions into streams nor eutrophy stream water. (Author's abstract)
W85-02171

EFFECTS OF CLEARCUTTING AND SITE PREPARATION ON STORMFLOW VOLUMES OF STREAMS IN PINUS ELLIOTTI FLATWOODS FORESTS

Southeastern Forest Experiment Station, Gainesville, FL.
B. F. Swindel, C. J. Lassiter, and H. Riekerk. Forest Ecology and Management, Vol. 5, No. 4, p. 245-253, April, 1983. 3 Fig., 2 Tab, 9 Ref.

Descriptors: *Storm runoff, *Forest management, *Clearcutting, *Pines, *Florida, Cutting management, Logging, Streamflow, Flood peak, Runoff, Windrowing.

Operational-sized watersheds in pine flatwoods of the Lower Coastal Plain in north Florida were isolated and continuously monitored for 3½ years. Recording flumes assessed quantity of runoff water. After 1 year of calibration monitoring, two of the three watersheds were harvested, site-prepared, and planted under distinct harvest and regeneration practices. Minimum practices, imposed on one watershed, consisted of manual shortwood harvest of pinelands, roller drum chopping of harvest of pinelands, roller drum chopping of harvest residues and residual understory, bedding, and planting. Maximum practices, imposed on another, consisted of tree-length logging off pinelands with heavy equipment, extraction of lightwood stumps, burning and windrowing of logging residue and residual understory, harrowing, bedding, and planting. Both silvicultural systems increased stormflow volumes; but the maximum practices increased stormflow volumes more. Stormflow volumes apparently increased immediately following tree harvests. The increase persisted through site preparation, planting, and subsequently for 1½ years without further detectable change. Based on this and two previous studies on the hydrologic response of flatwoods forests to silviculture, some conclusions were drawn. Peakflow rate is considered to be a sensitive parameter that may be detectably altered by silviculture, including clearcutting. Windrowing appears to be the most influential practice in increasing peakflow rates. Total surface water yield response is quite distinct depending on the silvicultural system employed. Practices that denude and level the soil surface and stream banks may produce a persistent increase in water yield.(Moore-IVI)
W84-04125

EFFECTS OF FOREST CLEARCUTTING IN NEW ENGLAND ON STREAM CHEMISTRY

Martin, C. W.; Noel, D. S.; Federer, C. A.; (Univ. of New Hampshire, Durham).
Journal of Environmental Quality; 13: No. 2, p. 204-210 (Apr-Jun 1984).

Differences in stream chemistry between recently clearcut and nearby uncut watersheds were generally small in a wide variety of soil and forest types throughout New England. Water samples were collected during six periods of the year in 1978 and 1979 from 6 entirely clearcut, 32 partially clearcut, and 18 uncut watersheds. The largest differences that could be attributed to harvesting occurred in entirely clearcut watersheds, especially in the White Mountains of New Hampshire. In one area of the White Mountains, inorganic N was 4 times higher (2 mg/L), and Ca was 2 times higher (4 mg/L) in streams from a clearcut watershed than in a nearby uncut watershed. Elsewhere, only minor changes in stream chemistry resulted from cutting; the amount of the cutting response was of the same magnitude as natural variations among streams draining similar watersheds. Clearcutting less than entire watersheds, patch and strip cuts, and buffer strips along streams draining similar watersheds. Clearcutting less than entire watersheds, patch and strip cuts, and buffer strips along streams all appear to reduce the magnitude of changes in stream chemistry.

EFFECTS OF FOREST CLEARCUTTING IN NEW ENGLAND ON STREAM CHEMISTRY

Northeastern Forest Experiment Station, Durham, NH. C. W. Martin, D. S. Noel, and C. A. Federer.
Journal of Environmental Quality, Vol. 13, No. 2, p. 204-210, April-June, 1984. 10 Fig., 1 Tab, 14 Ref.

Descriptors: *Water pollution sources, *Clear-cutting, *Stream pollution, Environmental effects, Watershed management, Forest management, Logging, Nitrogen, Calcium, Water chemistry.

Differences in stream chemistry between recently clearcut and nearby uncut watersheds were generally small in a wide variety of soil and forest types throughout New England. Water samples were collected during six periods of the year in 1978 and 1979 from 6 entirely clearcut, 32 partially clearcut, and 18 uncut watersheds. The largest differences that could be attributed to harvesting occurred in entirely clearcut watersheds, especially in the White Mountains of New Hampshire. In one area of the White Mountains, inorganic N was 4 times higher (2 mg/L), and Ca was 2 times higher (4 mg/L) in streams from a clearcut watershed than in a nearby uncut watershed. Elsewhere, only minor changes in stream chemistry resulted from cutting; the amount of the cutting response was of the same magnitude as natural variations among streams draining similar watersheds. Clearcutting less than entire watersheds, patch and strip cuts, and buffer strips along streams all appear to reduce the magnitude of changes in stream chemistry. (Author's abstract)
W84-05114

EFFECTS OF PRESCRIBED FIRE ON WATER QUALITY AT THE SANTEE EXPERIMENTAL WATERSHEDS IN SOUTH CAROLINA (CONF-8405237-1)

Richter, D. D.; Ralston, C. W.; Harms, W. R.; Gilliam, F. S. (Oak Ridge National Lab., TN (USA); Duke Univ., Durham, NC (USA). School of Forestry and Environmental Studies; Forest Service, Charleston, SC (USA). Forestry Sciences Lab.; Kansas State Univ., Manhattan (USA). Div. of Biology). 1984. Contract AC05-84OR21400. 19 p. NTIS, PC A02/MF A01; GPO Dep. File Number DE85001865.

From Southern regional meeting of National Council of the Paper Industry for air and stream improvement; Atlanta, GA, USA (30 May 1984).

Environmental Sciences Div. Publication No. 2379.

Prescribed fire is an important practice in the multiresource management of forests, and controlled burning is now applied annually to about 1 million hectares (2.4 million acres) of forest in the southeastern United States. Prescribed fires had few detectable effects on forest soils, nutrient cycling, and hydrologic systems of a pine-flatwoods watershed at the Santee Experimental Forest in the Francis Marion National Forest in South Carolina, a site of long-term watershed research by the U.S. Forest Service and Duke University. Experiments were designed so that treatment effects would simulate responses of an operational southern pine forest, and it was concluded that nutrient fluxes from burned pine litter to ground and stream eaters are not likely to have appreciable effects on the quality of waters that drain southern pine watersheds, especially those with fine-textured soils. 15 Ref., 4 Fig., 1 Tab.

EFFECTS OF SILVICULTURAL PRACTICES ON WATER QUALITY IN NORTHERN WISCONSIN

Wisconsin Univ. Stevens Point, WI, Coll. of Natural Resources. N. E. Spangenberg and R. McLennan.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-220517. Water Resources Center Technical Report WIS WRD 83-07, Univ. of Wisconsin, Madison, 1983. 17 p., 3 Fig., 2 Tab, 15 Ref. OWRT A-095-WIS(1), 14-34-0001-2153.

Descriptors: *Cutting management, * Forest management, *Forest watersheds, *Soil erosion, *Water quality, Clearcutting, Forest soils, Forestry, Mixed forests, Streams, *Wisconsin, Chequamegon National Forest.

Two areas in the Chequamegon National Forest were selected for studies of water quality and overland soil movement. One area, bordered on the North by the Marengo River, is a clearcut in a mixed hardwood stand with two small streams running through it. The second area is mixed hardwoods being logged with a selection cut. A stream runs through the active cutting area. Sample transects were established in the streams running through and bordering the timber harvest areas. Samples were collected at 2-week intervals and analyzed. Amounts of soil exposure and vegetative ground cover were estimated at random points along transects established in harvested and unharvested areas. Soil/vegetation data were collected at 2-week intervals. During the first growing season after clearcutting,

there were few significant changes in water quality that could be attributed to the timber harvest. Soil disturbances caused by rubber tire skidders were virtually healed. Logging debris and vegetation produced almost 100% groundcover early in the growing season. This provided a high degree of soil protection, which minimized soil erosion during the first growing season. Selection cut harvesting with rubber tire skidding had no impact on water quality in the first growing season after the harvest. Harvesting exposed a minimum of soil and the amount of vegetative cover did not change. It is doubtful that selection cutting increased soil erosion on the site during the first growing season.
W83-03304

ENRICHMENT OF TRANSPORTED SEDIMENTS WITH ORGANIC CARBON, NUTRIENTS, AND CLAY

Technion — Israel Inst. of Tech., Haifa, Depart. of Agricultural Engineering. Y. Avnimelech and J. R. McHenry.
Soil Science Society of America Journal, Vol. 48, No. 2, p. 259-266, March-April, 1984. 22 Fig., 7 Tab., 17 Ref.

Descriptors: *Nutrients, *Organic carbon, *Sediment transport, Nitrogen, Phosphorous, Enrichment ratio, Sediment yield, Sediment-carrying capacity, Sedimentation rates, Erosion, Soil properties, Particle size, Clay.

Much of the nutrient inflow into impoundments is the result of erosion of soil particles on the watershed, together with adsorbed nutrients and their movement from the upland watershed soils. As the detached particles move downstream, they undergo selective size segregation and the nutrients are subject to selective desorption and adsorption between the particles and the water. During transport an enrichment of clay sized particles and the water. During transport an enrichment of clay sized particles within the system occurs as well as that of P, N, and organic C. The ratio of the concentration of any given component in the eroded material system to that in the contributing soils is defined as the enrichment ratio. The selectivity of the erosional and sediment delivery process involved in the transfer of eroded materials from watersheds to lakes or reservoirs is assumed to be proportional to the time, or distance, of travel. This study compares the composition of the eroded material at the onset and at the termination of the erosion, or sedimentation, cycle. From this information insight into the mechanisms affecting the compositional changes along the erosional route may be obtained. Organic carbon, total nitrogen, and total phosphorous concentrations and clay contents in sediments from 41 impoundments or lakes were compared with the equivalent parameters in the soils of the contributing watersheds. The enrichment ratio of a given component (S/S sub of the concentration of the component in the eroded material divided by its concentration in the soil) was theoretically predicted to be: S/S sub o = 1/S sub o x L, where L is a limiting value representing a stable level of this component in the erosion sequence. The measured enrichment ratios for organic C and total N were in good agreement with the theoretical model, the stable levels being 24 and 1.7 g/kg for organic C and total N. No such agreement was found for P and clay enrichment ratios, possibly due to the effect of the variable flow conditions on the selective erosion of these compounds. (Author's abstract)
W84-04874

EROSION ON LOGGING ROADS IN NORTHWESTERN CALIFORNIA: HOW MUCH IS AVOIDABLE

J. D. McCashion and R. M. Rice
Journal of Forestry, Vol. 81, No. 1, p 23-26, January, 1983. 6 Fig., 2 Tab, 8 Ref.

Descriptors: *California, *Forest management, *Erosion rates, *Logging roads, Erosion control, Roads, Road construction.

A survey of logging roads in northwestern California to assess sources of erosion indicated that not all road-related erosion is preventable. The inventory included 344 miles of roads in Del Norte, Humboldt, Siskitou, and Trinity Counties; also included in the survey were 30,300 acres of commercial timberland. Erosion from a harvest area was compared to erosion on road rights-of-way. The roads surveyed included seasonal roads, all-weather secondary roads, and main-haul roads. Every 0.2 miles on the roads, the slope, grade, aspect, cut-and-fill heights, and other descriptors were recorded. Erosional events were classified as either naturally derived events, unavoidable road-related erosion, or avoidable road-related erosion. At most, about 24 percent of the erosion measured on the logging roads could have been prevented by conventional engineering methods (avoidable road-related erosion) and 37 percent was unavoidable (caused by site conditions and choice of alignment). On the timberland, an estimated 40 percent of the total erosion associated with management of the area was found to have been derived from the road system and 60 percent came from the logged area. (Collier-IVI)
W85-01164

FORESTS, FLOODS, AND EROSION: A WATERSHED EXPERIMENT IN THE SOUTH-EASTERN PIEDMONT

Georgia Univ., Athens, GA, School of Forest Resources. J. D. Hewlett and R. Doss. Forest Science, Vol. 30, No. 2, p. 424-434, June, 1984. 4 Fig., 2 Tab, 16 Ref.

Descriptors: *Erosion, *Forest management, *Flooding, *Georgia, *Forest watersheds, Forestry, Floods, Erosion, Storm runoff, Clearcutting, Cutting management, Road construction.

A paired watershed experiment to determine the effect of

clearcutting and regeneration of pine on the Georgia Piedmont showed that the small stormflows on dry soil may be increased 50 percent or more, but that larger flood discharges from wet soil were increased only 10 to 15 percent, if at all. The annual flood is apt to be of the latter type. The reasoned conclusion is that concern about the effects of forest operations on downstream flooding of creeks and rivers is unwarranted. However, peak rates of discharge immediately below the operation increased 30-45 percent, resulting in a 55 percent annual increase in stormflow erosiviy during the 4-year cycle of harvesting, site preparation, and machine planting. The increase in erosivity of stormflows following this typical southern forestry operation, when considered in light of the accompanying increase in erosion hazard due to soil disturbance, warns the forest manager to increase his vigilance over road design, the selection of regeneration methods, and the maintenance of streamside protection zones. (Author's abstract)
W85-01705

HYDROLOGIC IMPACTS OF A LARGE-SCALE MOUNTAIN PINE BEETLE (DENDROCTONUS PONDEROSAE HOPKINS) EPIDEMIC

Montana Univ., Missoula, MT, School of Forestry. D. F. Potts. Water Resources Bulletin, Vol. 20, No. 3, p. 373-377, June, 1984. 3 Fig., 3 Tab, 9 Ref.

Descriptors: *Forest watersheds, *Jack Creek watershed, *Montana, *Streamflow, *Pine beetles, Water yield, Forest management, Snowmelt, Flood peak, Tree mortality.

Forest ecosystems are affected regularly by catastrophic events such as wildfire or decimation by diseases or insects, but there has been a lack of observations on the hydrologic impacts of such events. The mountain pine beetle (Dendroctonus ponderosae) epidemic in 1975-1977 in the Jack Creek watershed in southwestern Montana presented a rare opportunity for such a study. The mountain pine beetle killed an estimated 35% of the total timber on the 133 sq km watershed. USGS streamflow data for four years prior to and five years after mortality were analyzed. The death of 35% of all timber in the drainage has apparently produced an average increase in annual water yield of about 15%. The reduction of evapotranspiration and interception loss following mortality and needle-fall is probably similar to that produced by timber harvest of the same magnitude. Post-epidemic snowmelt timing has been advanced two to three weeks. Because of desynchronization, even the estimated 15% increase in post-epidemic average annual water yield does not produce a great difference in the highest monthly (June) average water yield does not produce a great difference in the highest monthly (June) average water yield. This suggests that, in the absence of major site disturbance and soil compaction, timber harvest may not increase peak discharges. (Moore-IVI)
W85-01375

IDENTIFICATION OF RUNOFF SOURCES OF A FORESTED LOWLAND CATCHMENT. A CHEMICAL AND STATISTICAL APPROACH

Amsterdam Univ. (Netherlands). Lab. for Physical Geography and Soil Science. J. J. H. M. Duysings, J. M. Verstraten, and L. Bruynzeel. Journal of Hydrology, Vol. 64, No. 1/4, p. 357-375, July, 1983. 4 Fig., 7 Tab, 34 Ref.

Descriptors: *Forest watersheds, *Precipitation, Seasonal variations, Rainfall, Statistical analysis, Storm runoff, Snowmelt, Hydrology, Cachment areas, Water chemistry.

The seasonal and intra-storm variations in streamwater chemistry are described and used to distinguish runoff and solute sources in the catchment. Sources of solutes include those contained in water from: throughfall falling on the river channel and adjacent partial areas; litter-layer water and water from the organic-rich sandy topsoil (A1 horizon); or throughflow in he sandy layer (A2 horizon). Statistical treatment of the streamwater concentration data by means of factor and cluster analysis show the significant relationships and different behavior of three groups of solute species: K, NH4, NO3/Mg, Na, Cl/Ca, Si, SO4, each group having a different response to rainfall. The first group, K, NH4, and NO3 shows an increasing concentration during the first part of a storm and a decrease afterward. The second, Na, Cl, and Mg shows a lowered concentration during the first part of a storm with increases after the discharge peak is reached. The third, Ca, Si, and SO4, group shows dilution on the rising limb and enrichment on the falling limb of the hydrograph. In winter and spring, however, Si and SO4 show an earlier increase in concentration in contrast to Ca. Three types of storm events with specific hydrologic situations could be distinguished: winter and spring storms generating direct runoff and baseflow; summer and autumn storms generating only direct runoff; and snowmelt runoff. Each of these types of runoff event is characterized by a particular solute behavior, related to contributions from the different runoff and solute sources. The validity of this model of solute contributions by these sources (throughfall (stemflow), litter and soil waters) is corroborated by the measured concentration levels of these sources. (Baker-IV)
W84-02215

LOGGING IMPACTS AND SOME MECHANISMS THAT DETERMINE THE SIZE OF SPRING AND SUMMER POPULATIONS OF COHO SALMON FRY (ONCORHYNCHUS KISUTCH) IN CARNATION CREEK, BRITISH COLUMBIA

Department of Fisheries and Oceans, Nanaimo (British Columbia). Pacific Biological Station. J. C. Scrivener and B. C. Andersen. Canadian Journal of Fisheries and Aquatic Sciences, Vol. 41, No. 7, p. 1097-1105, 1984. 7 Fig., 2 Tab, 33 Ref.

Descriptors: *Salmon, *Logging, *Environmental effects, *Fry, *Carnation Creek, *British Columbia, Water temperature, Freshets, Fish behavior, Debris, Growth, Fish migration.

Natural patterns in emergence times, seaward movements, instream distributions, densities, and growth of coho salmon fry (Oncorhynchus kisutch) between march and September are contrasted with patterns observed during and after logging in the Carnation Creek watershed. After streamside logging in 1976-77, fry emerged up to 6 wk earlier and moved seaward more quickly than during years before logging. These observations are attributed to higher water temperatures during the winter and to emergence during a period of more frequent freshets. Increased fry movement from the stream could result in habitat being underutilized. In sections affected by intense streamside logging, the deposition of 'fine' logging debris led to increased fry densities during the summers of 1977 and 1978. After major freshets in November 1978, which removed this fine debris and affected channel morphology in these sections, fry densities declined below those observed prior to logging. Growth rate of fry was inversely correlated with density 8 in all stream sections. Growth rates, after correction for density, tended to be greater in all sections after the adjacent streamside was logged. Larger fry and more variable numbers of fry remained in the stream in September after logging than before logging. Their increased size is attributed to the longer growing season afforded by earlier emergence. This complex of interacting factors determines the number and size of fry in autumn and it can influence the production of smolts the following spring. (Author's abstract)
W85-01919

MODELING INTERCEPTION OF RAINFALL BY FORESTS AND THE ROLE OF INTERCEPTION IN THE WATER BALANCE

Murphy, C. E. Jr. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1984. Contract AC09-76SR00001. 37p. (CONF-8410181-1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE85002822.

From :Long-term ecological processes in forested waterbeds conference; Athens, GA, USA (15 Oct 1984).

Interception is an important component of the forest water balance that cannot be ignored where accurate water balance estimates are desired. The state of modeling the interception of rainfall has been greatly improved by the development of models using a dynamic canopy water balance. These models show promise of allowing prediction of interception for forests where detailed interception studies have not been done. There is certainly coupling of the forest water balance and the larger scale meteorological processes. However, it does no appear that evaporation of intercepted water takes place in a closed system and advection of dry air is available to keep evaporation rates relatively high under many conditions. This means that interception loss will change significantly with manipulation of forest cover and will affect the water balance. In climates where evaporation of interception is low, it is likely that much of the intercepted water evaporates after the rainfall period. In a post rainfall environment, it is possible for evaporation to be greater than transpiration even if sensible heat is not available as a source of energy. 21 Ref., 3 Fig., 2 Tab.

NUTRIENT AND HYDROLOGICAL EFFECTS OF THE PINE BARRENS ON NEIGHBORING ESTUARIES

Durand, J. B., pp 195-214 of Pine barrens: ecosystem and landscape. Forman, R.T.T. (ed.). New York, NY; Academic Press, Inc. (1979).

Primary production by the phytoplankton community in the Great Bay Estuary was controlled by the supply of nitrogen derived from the Mullica River drainage basin in the pine barrens. Low nitrate-nitrogen concentrations were found in streams of relatively undisturbed areas of the drainage basin, while high nitrate-nitrogen concentrations were characteristic of streams draining the agricultural and urban areas of the pine barrens. Low nitrogen levels often limited primary production, especially in the well-lighted bay. Primary production in the bay increased in response to nitrogen supplied by the river, even when the nitrogen was supplied in minute quantities. Salinity gradients in the estuary, maintained by the volume of river water flow, are critical to many estuarine animals. Thus, the relatively low nutrient levels and the amount and relative constancy of water flow in pine barrens streams have a major controlling and stabilizing effect on the ecosystems of the coastal estuaries.

OVERLAND FLOW, SEDIMENT OUTPUT AND NUTRIENT LOSS FROM CERTAIN FORESTED SITES IN THE CENTRAL HIMALAYA, INDIA

Kumaun Univ., Naini Tal (India). Dept. of Botany. P. C. Pahak, A. N. Pandey, and J. S. Singh.
Journal of Hydrology, Vol. 71, No. 3/4, p. 239-251, March, 1984. 7 Tab, 25 Ref.

Descriptors: *Surface flow, *Sediment yield, *Nutrient removal, *Forests, *Himalaya, *India, Sediment erosion, Cycling nutrients, Chemistry of precipitation.

The rainfall characteristics and hydrologic responses of the Himalayan forested catchments are relatively unknown. Evaluation of hydrologic components and nutrient fluxes is prerequisite to understanding the watershed ecosystems and management implications. Overland flow, sediment output, input and output of precipitation nutrients were evaluated on six forested sites in the central Himalaya during the 1981 and 1982 monsoon seasons. Overland flow was significantly different across the forests and the months of the rainy season. It was positively related with rainfall quantity and intensity, and was negatively related with tree canopy cover and with ground vegetation cover. Average overland flow was only 0.66% of the total incident rainfall, indicating that these sites are subsurface-flow systems. Sediment output was positively related to overland flow. Rainfall added a significant amount of nutrients to the

forests. This extra-system input was greater than loss through overland flow + sediment output. The loss of nutrients from the forested sites was in the order: Mg > C > Ca > K = N = P. (Murphy-IVI)
W84-04862

RIPARIAN FORESTS AS NUTRIENT FILTERS IN AGRICULTURAL WATERSHEDS

Georgia Coastal Plain Experiment Station, Tifton, GA, R. Lowrance, R. Todd, J. Fail, Jr., O. Hendrickson, Jr., and R. Leonard.

BioScience, Vol. 34, No. 6 p 373-377, June 1984. 2 Fig., 1 Tab., 18 Ref. NSF grants DEB 78-10841 and DEB 82-07210.

Descriptors: *Riparian vegetation, *Agricultural watersheds, *Nutrient removal, Sediment transport, Path of pollutants, Forests, Sodium, Phosphorus, Potassium, Magnesium, Chloride, Water pollution control.

Riparian vegetation (streamside) may help control transport of sediments and chemicals to stream channels. Studies of a coastal plain agricultural watershed showed that riparian forest ecosystems are excellent nutrient sinks and buffer the nutrient discharge from surrounding agroecosystems. Nutrient uptake and removal by soil and vegetation in the riparian forest ecosystem prevented outputs from agricultural uplands from reaching the stream channel. The watershed studied is 1568 ha with 30% riparian forest, 41% row crops, 13% pasture, and 16% roads, residences, fallow land, and other uses. Annual inputs of nutrients in fertilizer and lime to row crops and pastures in the uplands are high. Inputs, outputs, and vegetation storages of N, P, K, Ca, Mg, and Cl in the riparian ecosystem were measured from 1979 to 1981. Waterborne inputs exceeded streamflow outputs for all elements. The riparian ecosystem can apparently serve as both a short- and long-term nutrient filter and sink if trees are harvested periodically to ensure a net uptake of nutrients. Based on this study, good water quality for agricultural watersheds depends largely on nutrient uptake and removal in the riparian ecosystem. Removal of the riparian forest, accompanied by tile drainage, would tend to contribute to higher nutrient loads in streams and lower water quality through loss of nutrient uptake and storage by woody vegetation. (Baker-IVI)
W85-00127

SEDIMENT PRODUCTION FROM FOREST ROAD SURFACES

Washington Univ., Seattle. Dept. of Geological Sciences. L. M. Reid and T. Dunne.

Water Resources Research, Vol. 20. No. 22, p. 1753-1761, November, 1984. 8 Fig., 5 Tab, 13 Ref.

Descriptors: *Sediments, *Logging, *Forests, *Roads, *Soil erosion, Erosion, Paving, Road construction, Rainfall, Hydrographs.

Erosion on roads is an important source of fine-grained sediment in streams draining logged basins of the Pacific Northwest. Runoff rates and sediment concentrations from 10 road segments subject to a variety of traffic levels and types of surfaces. These relationships are combined with a continuous rainfall record to calculate mean annual sediment yields from road segments of each use level. A heavily used road segment in the field area contributes 130 times as much sediment as an abandoned road. A paved road segment, along which cut slopes and ditches are the only sources of sediment, yields less than 1% as much sediment as a heavily used road with a gravel surface. (Author's abstract)
W85-03576

SOIL LOSSES FORM ROADBEDS AND CUT AND FILL SLOPES IN THE SOUTHERN APPALACHIAN MOUNTAINS

Southeastern Forest Experiment Station, Asheville, NC. Coweeta Hydrologic Lab. L. W. Swift, Jr. Southern Journal of Applied Forestry, Vol. 8, No. 4, p. 209-216, November, 1984. 3 Fig., 1 Tab, 9 Ref.

Descriptors: *Road construction, *Soil erosion, *Slopes, *Coweeta, *North Carolina, Roads, Gravel, Grass, Soil loss, Storm runoff, Freeze-thaw cycle, Road cuts, Fill.

Roads are often the major source of soil erosion form forested lands. The roadway, or area of exposed soil of a newly constructed road, consists of three distinct surfaces with different characteristics that affect their erodibility: the cut slope, the roadbed, and the fill slope. Measurements were made on an access road to a Forest Service timber sale at Coweeta Hydrologic Laboratory, North Carolina. Before grass was planted on gravel spread, roadbed surfaces had the least loss per unit area and loss was primarily waterborne fine particles. A large part of the soil loss from fill slopes was due to slippage of wet soils in early spring. Surface erosion of fills was negligible because storm water from the roadbed was not spilled across loose soil. The cut slopes eroded most, principally because soils were loosened by diurnal cycles of freezing and thawing in winter. Inclined surfaces of cut and fill slopes are potential sources of large soil loss but these losses can be mitigated by early establishment of grass cover and by design features to control storm water. Soil loss from roadbeds was generally reduced by gravel surfacing. Without protection, heavy rains remove large amounts of soil from all portions of the roadway. (Moore-IVI)
W85-03318

STREAM TEMPERATURE UNDER AN INADEQUATE BUFFER STRIP IN THE SOUTHEAST-PIEDMONT

Georgia Univ., Athens, GA, School of Forest Resources.J. D. Hewlett and J. C. Fortson.

Water Resources Bulletin, Vol. 18, No. 6, p. 983-988, December, 1982. 5 Fig., 9 Ref.

Descriptors: *Forest watersheds, *Logging, *Water temperature, Buffer zones, Clear-cutting, Forest management, Temperature, Stream degradation, Piedmont, Putnam County, * Georgia, Environmental effects, Watershed management.

The effects of clearcutting loblolly pine on stream water quality were determined in a paired watershed study in Putnam County, Georgia. The control watershed was left in its original state, while the logged area had a partial and irregular buffet strip of 20 ft covering each bank for about 50% of its total length. Water temperatures in the logged watershed in summer were as much as 20°F higher than the control. These observed results did not agree with results from Brown's stream temperature model, which predicted much smaller temperature variations. Results suggest that in areas of gentle land relief even a substantial buffer strip may be insufficient to preserve lower temperatures in shallow groundwater moving toward the stream. (Cassar-FRC)
W83-03149

SURFACE RUNOFF WATER QUALITY COMPARISONS BETWEEN UNIMPROVED PASTURE AND WOODLAND

Science and Education Administration, Coshocton, OH. North Appalachian Experimental Watershed. L. B. Owens, W. M. Edwards, and R. W./ Van Keuren.
Journal of Environmental Quality, Vol. 12, No. 4, p, 518-522, 1983. 2 Fig., 5 Tab. 23 Ref/ EPA grant R-804631.

Descriptors: "Surface runoff, "Water quality, Comparison studies, Pastures, Woodlands, Chemical properties, Sediment transport, Organic compounds, Input-output analysis.

The influence of pasturing on surface runoff water quality was studied on a 26 ha, unimproved pasture watershed in eastcentral Ohio. Data were collected for 2 years with no cattle in the pasture and for 3 years with summer grazing by a 17-cow beef cattle herd. Because of springs and seep areas in the pasture, a small stream (accessible to the cattle) in the watershed flowed permanently. Samples of storm runoff were collected with a rotating vane sampler. The concentrations of most of the measured chemical parameters (N03-N, mineral N, organic N, total P, K, Ca, Mg, Na, S, C1, HCO3, total organic C, salts) in the storm discharge water were low and changed very little as a result of grazing. The weighted annual NO3-N concentrations for the ungrazed period and grazed period were 0.5 and 0.7 mg/L, respectively. A 17.7-ha, wooded watershed that contained no pastured areas and received no agricultural chemical limits, had concentrations of chemical parameters in surface discharge that were greater than or equal to those from the unimproved pasture during the grazing period. Nutrient transport during storm runoff from the unimproved pasture was greater during the 3-year period with summer grazing than during the 2-year, ungrazed period. This largely resulted from increased precipitation and subsequent increased surface runoff during the 3-year period. The transport levels from the pasture during the 3-year period were similar to or less than the transport levels from the wooded watershed during the same period. The increase in sediment transport from the pastured areas was more than could be attributed solely to the increased surface runoff. (Author's abstract)
W84-03930

THE EFFECTS OF FOREST HARVEST ON WATER QUALITY AND AQUATIC LIFE (PHASE I)

Arkansas Univ. at Monticello, AR, Dept. of Natural Sciences, E. J. Bacon.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-246413, Price codes: A04 in paper copy, A01 in microfiche. Water Resources Research Center Publication No. 100, Univ. of Arkansas, Fayetteville, March 1983. 72 p., 1 Fig., 19 Tab, 1 Append. OWRT A-052-ARK(1), 14-34-0001-0104.

Descriptors: *Nitrogen, *Phosphorous, Water quality, Watershed, *Sediments, Ecosystems, species diversity, management planning, *Small watersheds, Runoff, Sedimentation, Macroinvertebrates, Fish, Bioindicators, Standing crops, *Arkansas, Little Missouri River, *Clearcutting.

A long term study on the effects of clearcut forest harvest and regeneration was conducted in a representative watershed of the Ouachita National Forest. Fourteen water quality parameters were analyzed to characterize baseline water quality. Water quality was classified as excellent. A total of 350 quantitative benthic samples and 15 ultraviolet light trap samples yielded 173 species of macroinvertebrates. Mean densities of macroinvertebrates ranged from 4,800/m super 2 to 23,040/m super 2 in the upper Little Missouri River. Twenty-two quantitative collections of fishes were made at representative riffles and pools. The average biomass estimates for riffles and pools were 5.69 kg/ha and 16.66 kg/ha, respectively. The total numbers of individuals per hectare were higher in riffles han pools. Lower standing crops of fish were observed in a tributary stream to the main river. A Phase II study will evaluate and summarize the effects of clearcutting approximately 113.3 hectares of deciduous forest on water quality and aquatic life in the watershed.
W83-03686

MINING

ABANDONED MINE LAND RECLAMATION AND STORM WATER MANAGEMENT

Young, S.E. (Rural Abandoned Mine Program, Bloomsburg, Pennsylvania). ASAE (American Society of Agricultural Engineers) Technical Paper; 83-2621: 12(Dec 1983). (CONF-831275-).

From Winter meeting of the American Society of Agricultural Engineers; Chicago, IL, USA (13 Dec 1983).

Studies of several surface coal-mining sites in western North Dakota have resulted in the development of a hydrogeochemical model which accounts for the observed chemical characteristics of subsurface water in undisturbed settings. Critical hydrogeochemical processes include sulfide oxidation, gypsum precipitation and dissolution, carbonate mineral dissolution and cation exchange. In the semi-arid climate of western North Dakota, the near-surface several metres of the landscape is constantly subjected to alternate wetting/drying. This mechanism is the key to hydrogeochemical evolution of both pore water in the rooting zone and subsurface water that eventually reaches the water table. Recent refinements in the hydrogeochemical model have focused on the sulfer cycle and determination of the applicability of the model to postmining (spoils) landscapes. Field activities have included detailed groundwater instrumentation of undisturbed and spoils areas at two geologically distinctive mine sites in western North Dakota.

CHARACTERIZATION OF ORGANIC COMPOUNDS IN SIMULATED RAINFALL RUNOFFS FROM MODEL COAL PILES

Texas Univ. Health Science Center at Houston, TX, School of Public Health. R. G. Stahl, Jr., J. G. Liehr, and E. M. Davis. Archives of Environmental Contamination and Toxicology, Vol. 13, No. 2, p. 179-190, March, 1984. 6 Fig., 6 Tab, 38 Ref.

Descriptors: *Coal, *Water pollution sources, *Organic compounds, Rainfall runoff, Simulation, Sulfur, Phenanthrene, Aliphatic compounds, Polycyclic aromatic hydrocarbons, Hydrocarbons.

Model coal piles were constructed and leached with distilled water under simulated rainfall conditions. The piles were composed of one of four coals: two of high sulfur content (Illinois No. 6 and Western Kentucky), one of low sulfur content (Montana Nerco), and one of variable sulfur content (Texas lignite). There were nine rainfall simulations spaced 15 days apart. The runoffs were collected, extracted at acid and base pH, and analyzed by capillary column gas chromatography/mass spectrometry (GC/MS). Also, an extreme case was simulated by stir-extracting a coal with three different organic solvents in an acid and base medium, and the extracts were analyzed by GC/MS. The most common organic compound identified in any extract was phenanthrene. Aliphatic hydrocarbons and polycyclic aromatic hydrocarbons (PAHs), and methyl and ethyl substituted PAHs were also identified. The concentration of most of the compounds did not exceed 50 micro g/L. The concentrations of compounds in the extreme case simulations ranged from below detection (< 1 micro g/L) up to 107 micro g/L. The data demonstrated that runoffs from coal piles may contain numerous organic compounds including many PAHs. (Author's abstract)
W85-02200

CHARACTERIZATION OF ORGANIC COMPOUNDS IN SIMULATED RAINFALL RUNOFFS FROM MODEL COAL PILES

Stahl, R.G. Archives of Environmental Contamination and Toxicology; 13: No. 2, p. 179-190 (1984)

Several model coal piles were constructed from each of 4 types of coal and leached with distilled water to simulate rainfall conditions. Runoff samples were collected, extracted and analyzed by capillary column gas chromatography/mass spectrometry. Runoff from coal piles could contain numerous organic compounds, including phenanthrene, aliphatic hydrocarbons, PAH, and methyl and ethyl-substituted PAH.

CHEMICAL CHARACTERISTICS OF SURFACE RUNOFF FROM SOILS AND REVEGETATED LIGNITE MINE SPOILS

Texas A and M Univ., College Station, TX, Dept. of Soil and Crop Sciences. K. W. Brown, J. C. Thomas, and L. E. Deuel, Jr. Journal of Soil and Water Conservation, Vol. 39, No. 2, p. 146-149, March-April, 1984. 4 Fig., 1 Tab, 9 Ref. BM grant J0295016.

Descriptors: *Spoil banks, *Texas, *Water pollution sources, *Land reclamation, Surface runoff, Topsoil, Lignite, Water quality, Revegetation, Storm runoff, Hydrogen ion concentration, Conductivity, Iron, Manganese.

Surface runoff from three revegetated lignite mine spoils and nine native soils on three geological deposits along the Texas Gulf Coast were evaluated. Purpose was to compare water quality from revegetated, nontopsoiled spoils with that from undisturbed soils. Field plots 4.6 x 9.5 m x 10 m deep were established on revegetated, nontopsoiled test pits at each geological deposit and on three soils representative of each of the three areas to be mined. Stormwater runoff from natural rainfall events was sampled following major storms and analyzed for pH, electrical conductivity (EC) soluble Fe, and Mn. Although runoff water pH from revegetated spoil on the Jackson deposit was low initially, a slow increase occurred during the first 15 months after revegetation. Runoff pH from spoils was eventually similar to that from soils. Runoff water pH from revegetated spoil on the other two geological deposits was similar to that from

the soil during the first 15 months after revegetation. EC of runoff water from revegetated spoil was less than 3 dS/m for all sites immediately after revegetation and declines to background levels within 1 year. Concentrations of Fe in runoff exceeded 3.5 mg/l during the first 6 months following revegetation; however, later concentrations were similar to those from soils. The Fe concentration in runoff from the Jackson deposit spoil and topsoils was low, but the concentration from spoil increased slightly with time. The concentration of soluble Mn in runoff was initially greater than 2.0 mg/l from revegetated spoil on the Jackson and Claiborne deposits but declines to background levels after 4 months. Initially, EC and soluble Fe and Mn concentrations in runoff from revegetated spoil on several of the deposits studied were greater than desirable. However, they reached concentrations comparable to those in runoff from adjacent soils within 4 to 15 months after the initial phases of revegetation. (Author's abstract)
W84-05057

COAL MINE DRAINAGE EFFECTS ON A LOTIC ECOSYSTEM IN NORTHWEST COLORADO, U.S.A.

Chadwick and Associates, Littletone, CO., J. W. Chadwick and S. P.Canton. Hydrobiologia, Vol. 107, No. 1, p. 25-33, October, 1983, 3 Fig., 6 Tab, 25 Ref.

Descriptors: *Mine drainage, *Coal mines, *Trout Creek, *Colorado, *Aquatic life, Periphyton, Invertebrates, Fish, Water pollution effects, Algae, Species diversity, Strip mine wastes, Insects, Biomass, Abundance.

An aquatic biological survey was conducted in 1979-1980 to determine the effects of drainage from an active coal strip-mine on Trout Creek, in northwest Colorado. Sampling was conducted over four seasons at four stations for periphyton, benthic invertebrates and fish. Periphyton in Trout Creek changed in the relative abundance of algae divisions in no apparent relation to mining. Diatoms were the predominant divisions at all sites. Golden-brown algae were abundant in spring at the stations upstream and adjacent to the mine. Blue-green algae were relatively important at stations upstream and downstream of the mine in winter. Benthic invertebrates exhibited a progressive increase in diversity, biomass and number of taxa from the upstream station to the downstream station. Shannon-Wiener diversity index for benthic invertebrates decreased slightly downstream of mine drainage but remained indicative of a clean water community. Aquatic insects (especially Trichoptera) were the predominant invertebrates at all stations. Analysis of functional groups of benthic invertebrates revealed importance of collector species at the lower sites while shredders were most important upstream of the mine. Unlike the invertebrates, fish exhibited slightly lower biomass at stations adjacent to the mine. The decrease was due to fewer salmonids. However, salmonid density and biomass increased substantially at the station just downstream of the mine. Nongame species (suckers and minnows) increased in numbers downstream and were most abundant at the lowest station. This coal strip-mine had little discernable adverse effects on the periphyton and invertebrates of Trout Creek. Fish populations did not appear to be significantly affected by the mine. Apparently, the presence of settling ponds and a buffer zone of unmined land between the mine and the stream helped to minimize adverse effects. (Author's abstract)
W85-00991

CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT OF COAL SURFACE MINING IN NORTH GEORGIA — SURFACE WATER. (TVA/PUB-84/81)

Poe, M.L.; Betson, R.P. (Tennessee Valley Authority, Norris (USA)). Oct 1983. 83 p. NTIS, PC A05/MF A01. File Number DE85900241.

Flow and water-quality data for surface water in the north Georgia coal region is presented in this report. The data were collected by TVA and the USGS; the TVA data were collected in July 1981 and the USGS data were collected primarily from 1979 through 1981, with some dating back to 1976. An analysis of the potential for surface-water quantity and quality problems due to future surface mining of coal is also presented. Several areas exhibiting this potential are listed, with the potential for erosion being the most widespread and the potential for acid drainage being localized but more difficult to prevent. 43 references, 6 figures, 14 tables.

HYDROLOGIC RESPONSES OF STREAM'S TO MINING OF THE MULBERRY COAL RESERVES IN EASTERN KANSAS

Geological Survey, Lawrence, KS. Water Resources Div. H. E. Bevans. Available from OFSS, USGS, Box 25425, Fed. Ctr. Denver, CO 80225. USGS Water-Resources Investigations Report 84-4047, 1984, 30 p., 12 Fig., 6 Tab, 13 Ref.

Descriptors: *Water quality, *Streamflow, *Coal mining, Dissolved solids, Sulfate, Suspended sediment, Flow duration, Storm runoff, Detention reservoirs, *Coal hydrology, *Kansas, Marais des Cygnes River, Little Osage River, Linn County, Miami County, Bourbon County, Mulberry Coal.

The U.S. Geological Survey investigated the hydrologic responses of streams with respect to coal-mining activities in the Mulberry coal reserves of Miami, Linn, and Bourbon Counties, eastern Kansas. Results of a low-flow water-quality reconnaissance showed that small streams draining previously coal-mined areas generally have relatively large concentrations of sulfate. Large streams in the study area have been relatively unaffected by coal mining. A comparison of two small drainage basins showed that the basin affected by an active strip mine had less high flow and more low flow because of the regulating effects of sediment ponds. Effluent pumped from the strip mine increased the load of sulfate by 244 percent, the load of dissolved solids by 41 percent, and occasionally transported relatively large concentrations of iron, lead, manganese, and zinc to the

receiving stream. Accelerated erosion caused by the exposure and disturbance of soil during clearing and excavation increased the sediment load of the receiving stream by 25 percent even though sediment ponds were installed. (USGS)
W84-01782

IMPROVED METHODS AND GUIDELINES FOR MODELING STORMWATER RUNOFF FROM SURFACE COAL MINED LANDS

Kentucky Water Resources Research Inst., Lexington, KY, M. E. Meadows and G. E. Blandford. Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111731, Price codes: A06 in paper copy, A01 in microfiche. Research Report No. 147, September 1983. 141 p., 21 Fig., 18 Tab, 64 Ref. OWRT B-069-KY(1), 14-34-0001-0222.

Descriptors: *Stormwater runoff, *Strip mines, Mathematical models, *Hydrologic models, *Synthetic hydrology, *Small watersheds, *Model studies, Simulation, Curve number, Unit hydrographs, Kinematic runoff, Green-ampt infiltration, Finite element, Modified Newton-Raphson interation, Excess rainfall pattern.

The investigations, developments and guidelines for several hydrologic modeling strategies are presented. Investigations were conducted to determine appropriate event curve numbers for surface mined disturbed watersheds; and performance of four synthetic unit hydrograph models (SCS curvilinear, SCS single triangle, Williams and TVA double triangle) on 38 USDA experimental watersheds in 14 physiographic provinces using in excess of 270 events. A second test using only the SCS curvilinear unit hydrography on 11 small watersheds and 48 events was conducted to investigate the excess rainfall simulated with the curve number model. A procedure for developing a unit hydrograph using the time area method and two parameter gama distribution is presented for ungaged watersheds or watersheds, undergoing land use changes. The development of a coupled explicit finite difference Green and Ampt infiltration-implicit finite element kinematic water model is presented. The deterministic overland flow model includes a variable width which is essential for accurate modeling of the watershed geometry. Both impervious and pervious watershed simulations are presented for the deterministic overland flow model.
W84-00033

LEACHING OF METALS AND TRACE ELEMENTS FROM SULFIDE-BEARING COAL WASTE IN SOUTHWESTERN ILLINOIS

Krothe, N.C.; Edkins, J.E.; Schubert, J.P. (Indiana Univ., Bloomington (USA). Dept of Geology; Argonne National Lab., IL (USA)). 1980. Contract W-31-109-ENG-38. 10P. NTIS, PCA02/MF A01. Order Number DE83010589. From Symposium on surface mining hydrology, sedimentology and reclamation; Lexington, KY, USA (1 Dec 1980). Portions are illegible in microfiche products.

Metal sulfides, chiefly pyrite and minor sphalerite, associated with the Herrin (No. 6) coal member of the Pennsylvanian Carbondale Formation, have been concentrated in coal refuse deposit in southern Illinois. Chemical, petrographic, and x-ray diffraction data for 34 cores, show that the upper two meters of material have been leached of sulfides in the thirty years since washing operations ceased. Oxidation of pyrite has produced highly acid waters with high concentrations of iron, zinc (up to 200 parts per million) and toxic trace elements that have leached downward to a water system perched on the underlying Illinoisan glacial drift. Drift well samples in the refuse pile are more saturated with metals than are the runoff waters and shallow-well samples. Metal recovery does not appear to be economically feasible at this site.

METHODOLOGY FOR HYDROLOGIC EVALUATION OF A POTENTIAL SURFACE MINE: LOBLOLLY BRANCH BASIN TUSCALOOSA COUNTY, ALABAMA

Geological Survey, Denver, CO. Water Resources Div. L. M. Shown, D. G. Frickel, R. F. Miller, and F. A. Branson. Available from the National Technical Information Service, Springfield, VA 22161 as PB82-238361, Price codes A04 in paper copy, A01 in microfiche. Geological Survey Water-Resources Investigations 82-50, 1982, 93 p., 12 Fig., 16 Tabs, 70 Ref.

Descriptors: *Estimating equations, *Evaluation, *Coal mining, *Land reclamation, Surface water, Groundwater, Water quality, Vegetation, Soil water, Soil porosity, Flow characteristics, Flood peak, Detention reservoirs, Sediment yield, *Alabama, Tuscaloosa County, Warrior Coal Field.

Methodology for evaluation of premining hydrology and postmining effects and reclamation on the hydrology of an area is presented for a potential mine site in northwestern Alabama. Estimation techniques and extrapolation are used to develop data for reconstructed topography, soil-water relations, peak flows, flow volumes, soil losses, and sediment yields. Streamflow response of the basin is described by the variable-source-area concept; nearly all water flows through coarse-textured soils and unconsolidated sand and gravel deposits that are underlain by an impermeable clay zone. The resultant peak discharges are small to moderate, and there is very little erosion of slopes or channels. Susceptibility of the soils to compaction by heavy machines and the effects of compaction on soil-water relations are demonstrated. Estimates of peak discharges made with four methods are divergent, particularly for recurrence intervals of 2, 5, and 10 years; divergence is less for 25, 50, and 100 year discharges. A premining estimate of sediment yield made with the Universal Soil Loss Equation and Sediment-delivery ratio is about 2.5 times larger than an estimate made with the sediment rating curve flow duration methods. (USGS)
W83-02976

METHODS FOR ASSESSING THE QUALITY OF RUNOFF FROM MINNESOTA PEATLANDS

Clausen, J. C. Minneapolis, MN, USA; Univ. of Minnesota (1981), 200 p. University Microfilms Order No. 82-11,464. Thesis (PhD.).

The quality of runoff from large, undisturbed peatlands in Minnesota is characterized and sampling results from a number of bogs (referred to as a multiple watershed approach) was used to asses the effects of peat mining on the quality of bog runoff. Runoff from 45 natural peatlands and one mined bog was ampled five times in 1979-1980 and analyzed for 34 water quality characteristics. Peatland watersheds were classified as bog, transition, or fen, based upon both water quality and watershed characteristics. Alternative classification methods were based on frequency distributions, cluster analysis, discriminate analysis, and principal component analysis results. A multiple watershed approach was used as a basis of drawing inferences regarding the quality of runoff from a representative sample of natural bogs and mined bog. The multiple watershed technique applied provides an alternative to long-term paired watershed experiments in evaluating the effects of land use activities on the quality of runoff from peatlands in Minnesota.

MINE DRAINAGE AND ROCK TYPE INFLUENCES ON EASTERN OHIO STREAM WATER QUALITY

Helsel, D.R. (Geological Survey, Reston, VA.). Water Resources Bulletin 19: No. 6, p. 881-887 (Dec 1983).

Stream water during fair weather (base flow) is largely ground water discharge, which has been in contact with minerals of the underlying aquifer. Base flow water quality should therefore reflect aquifer mineralogy as well as upstream land use. Three upstream mining categories (unmined lands, abandoned coal mines, and reclaimed coal mines) differed in pH, specific conductance, sulfate, iron, aluminum, and alkalinity for 122 streams in eastern Ohio. Aquifer rock type influenced PH, specific conductance, sulfate, iron, and alkalinity. Reclamation returned many components of acid mine drainage to near unmined levels, although sulfate and specific conductance were not improved. Acid mine drainage problems were less severe in watersheds underlain by the calcareous Monongahela Formatiion. These results should apply to other Appalachian coal regions having similar rock units. The water quality data distributions were neither consistently normal or lognormal. Statistical tests utilizing ranks of the water quality data, instead of the data themselves, proved useful in analyzing the influences of mining category and rock type.

MINED LAND RECLAMATION USING POLLUTED URBAN NAVIGABLE WATERWAY SEDIMENTS. II. ORGANICS

Van Luik, A. (Argonee National Lab., IL). Journal of Environmental Quality; 13: No. 3, p. 415-422 (Jul-Sep 1984).

Maintenance dredging potentially produces an estimated 15,000 m3 of sedimentary material from the calument-Sag Channel (Cal-Sag) annually. To determine the suitability of this dredge material for use in the reclamation of abandoned mined lands, 10 sediment samples were taken at 2.4-km intervals along the length of the Cal-Sag using a gravity corer. Sediment cores (107 to 173 cm in length) were subdivided to represent 40- to 50-cm depth increments, and composite samples were taken along the length of each subsample. Organic pollutant concentrations as well as silt and clay contents were determined. No significant correlations existed between each organic pollutant concentration and sediment sample depths, locations, or sediment silt or clay content. This result suggested that the mean and the mean plus twice the standard deviation offered good approximations of the expected mean value and the expected (95%) maximum value for these pollutants in Cal-Sag dredged material (volatile solids; 9.85 and 13.1 mg/kg; oil and grease; 11.9 and 22.7 g/kg; total phenols; < 2.4 and < 4.8 mg/kg; and total polychlorinated biphenyls (PCB's): 7.0 and 17 mg/kg). Polycyclic aromatic hydrocarbon (PAH) levels were determined for nine selected Cal-Sag sediment samples. Measured parent PAH compound levels (46 compounds) exceeded 80 mg/kg in only one sample. Alkyl-substituted PAH compound concentrations were measured for three parent compounds in three sediment samples and found to be highly variable in concentration ($\sim$1-$\sim$500 mg/kg).

MINED LAND RECLAMATION USING POLLUTED URBAN NAVIGABLE WATER SEDIMENTS. I. TRACE METALS

Van Luik, A. (Argonne National Lab., IL). Journal of Environmental Quality; 13: No. 3, p. 410-414 (Jul-Sep 1984).

As part of a study assessing the suitability of sediments from the Calument-Sag Channel, Illinois (Cal-Sag), for use as a mined land reclamation medium, the concentrations of 11 trace metals were determined in 34 sediment samples representing 10 cores. The cores were taken at 2.4-km intervals along the length of the Cal-Sag using a gravity corer. The cores (107 to 173 cm in length) were divided into sections representing approximately 30 to 50 cm of core depth each. Each of these sections was sampled by compositing a sample from along its length. Silt and clay content were determined in addition to the concentrations of the 11 trace metals. Trends in the metal concentration data suggested that As and Hg had a different source and/or history in the Cal-Sag sediments than Ba, Cd, Cr, Cu, Pb, and Zn. Nickel, selenium, and silver levels were determined for 10 of the samples. Implications of trace metal levels in terms of using Cal-Sag sediments as a plant-growth medium in mined land reclamation are discussed. Zinc levels may preclude use of Cal-Sag sediments for the production of some specific Zn-sensitive agronomic crops and may require long-term monitoring after placement in productive use to allow management of potential Zn phytotoxcity. Mean total trace metal concentration values for this

Cal-Sag sediments sampling were (mg/kg): As, 19; Ba, 320; Cd, 9.4; Cr, 110; Cu, 120; Pb, 510; Hg,<0.42; Ni, 38; Se, 0.10; Ag, 4.9; and Zn, 2580.

MINED LAND RECLAMATION USING POLLUTED URBAN NAVIGABLE WATERWAY SEDIMENTS. III. EXPERIENCE AT A DEMONSTRATION SITE

Van Luik, A.; Harrison, W. (Argonne National Lab., IL). Journal of Environmental Quality; 13: No. 3, p. 423-431 (Jul-Sep 1984).

Eroding ridges of acidic coal-mine spoil near Ottawa, IL were leveled to form a gently sloped raised plateau. Four test plots were constructed: a control plot and three treatment plots that received a 0.9-m thick cover of dredged material. Two of the treatment plots received lime applications, and all plots were seeded with a mixture of grasses. Porous ceramic cup soil water samplers were installed, in duplicate, at two levels in the control plot and at three levels in each treatment plot. The three levels in the treatment plots coincided with dredged material, the dredge material/mine spoil interface, and the underlying mine spoil. Nineteen water-quality parameters were monitored during the 4 years of the study. Results showed that the near-surface soil-water in the control plot deteriorated with respect to pH during the first 2 years and stabilized thereafter. The deeper control-plot samples showed no significant change in soil-water quality. The dredged material soil-water pH decreased slightly after placement, with the onset of lush vegetative growth. The solutions collected from the dredged material/mine spoil interface were neutralized during the first 2 years of the study, and dissolved trace metal levels dropped significantly during the first and succeeding years. The applied dredged material has significantly ameliorated the acidity and trace-metal levels of water in the underlying mine spoil, and appears to be an effective and safe reclamation medium, under proper use and management.

QUALITY AND QUANTITY OF RUN OFF AND GROUNDWATER IN TWO OVERBURDEN PYRITIC OXIDATION

Daniel, J.A.; Harries, J.R. Ritchie, A.I.M., (Austrailian Atomic Energy Commission Research Establishment, Lucas Height). pp vp of proceedings of international specialist conference on water regime in relation to milling, mining and waste treatment including rehabilitation with emphasis on uranium mining. Melbourne, Australia; the Association (1983). (CONF 8309275-).

From International specialist conference on water regime in relation to milling, mining and waste treatment; Darwin, Australia (4 Sep 1983).

The quality and quantity of runoff and seepage water from two waste rock dumps at the abandoned uranium mine at Rum Jungle, N.T., have been monitored over various time intervals since 1975. Both dumps contain pyrite which is oxidising and solubilising trace metals within the dumps. Results are presented for the quality and quantity of runoff from both dumps measured in the 1980-81 wet season. The rainfall/runoff characteristics of the two dumps measured during the wet season are similar and in good agreement with measurements made in previous wet seasons. Pollution loads in runoff were only a few percent of pollution loads in water percolating through the base of the dumps. The rainfall/runoff characteristics and the donimance of pollution loads in water percolating though the dumps are likely to apply to other similar waste rock dumps.

TRACE ELEMENTS IN NORTHERN GREAT PLAINS STRIP MINE AND LIVESTOCK IMPOUNDMENT WATER

Anderson, M.T.; Hawkes, C.L. Siskiyou National Forest, Grants Pass, OR. Water Resources Bulletin; 20: No. 2, 251-253 (April 1984).

The water from 32 strip mine water impoundments and mine livestock watering ponds in North Dakota, South Dakota, and Wyoming were analyzed from trace elements. Because of the high concentrations of trace elements in coal and bentonite clay, the possibility exists for these elements to dissolve or be suspended in the water. Strip mine ponds were not significantly higher in trace element concentration compared to livestock ponds. All but one of the 41 ponds sampled contained elemental concentrations that would be detrimental for livestock use or aquatic life use. Cadmium and lead were the elements most frequently in excess of water quality criteria. Lead was found in the study ponds about 35 times the mediam concentration of North American rivers. Manganese concentrations were found to exceed iron in many ponds, which is unusual in natural waters. The potential for detrimental concentrations of trace elements in pond water must be evaluated when designing land use management plans for ponds intended to be used by livestock or aquatic life.

RAPID DRAINAGE OF COAL SEAMS FOR PREVENTION OF ACID FORMATION

R. B. Watson. Water Science and Technology, Vol. 15, No. 2, p 103-114, 1983. 6 Fig., 2 Tab.

Descriptors: *Coal mining, *Acid mine drainage, Mine wastes, Boreholes, Drainage, Water pollution control, Adits.

The drainage of mineralized water from both operating and abandoned coal mines is a problem and clearly constitutes a serious source of stream pollution in the coal fields. The degree of acidity in mine drainage water can be reduced by removing the water from a mine as soon as practically possible. Coal extraction methods being used in South Africa are reviewed along with a study of the formation of acid mine water and drainage methods employed, which do provide some degree of success in the limitation of the acid content of the resultant mine drainage. Methods discussed include pumping (a common method of water

removal which can be costly due to the corrosiveness of the waters being pumped), drainage adits (the method used being to drive a tunnel from below the coal seam outcrop to a point beneath the water accumulation), and borehole drainage systems. Success has been promising for the rapid drainage of water from the workings of coal mines. The means by which drainage is effected from a mine will depend largely on the circumstances of the mine. Factors such as depth, mining method, quantity of water and whether or not acidity is likely to occur, have a bearing on the decision. (Baker-IVI)
W84-05090

RECLAMATION OF BITUMINOUS STRIP MINE SPOIL BANKS WITH MUNICIPAL SEWAGE SLUDGE

Seaker, E.M.; Sooper, W.E. (Pennsylvania State Univ., University Park). Reclamation and Revegatation Research; 3: No. 2, 87-100 (Sep 1984).

Municipal sludge was incorporated into spoil material at rates of 11,90 and 184 dry Mg ha^{-1} to reclaim an abandoned strip mine site in Pennsylvania in 1977. A monitoring system was installed to determine the effects of the sludge application on the quality and growth of the vegetative cover, the chemical properties of the soil, and chemical and bacteriological quality of the groundwater. Data collected over a 5-year period indicate that the sludge applications ameliorated the adverse site conditions and facilitate the establishment of a complete vegetative cover, which has persisted and improved each year. Sludge applications resulted in slight increases in some trace metal concentrations in the surface soil and in the vegetation. Soil concentrations were within the normal range found in US soils. Vegetation foliar trace metal concentrations were well below plant tolerance levels and no phytotoxicity symptoms were observed. The sludge applications had no significant adverse effect on the chemical or bacteriological quality of groundwater. The results indicate that single applications of stabilized municipal sludges, applied at rates up to 184 dry Mg ha^{-1}, can be used successfully to establish vegetation on mined land and maintain it for the 5-year period mandated under the Federal Surface Mining Control and Reclamation Act of 1977.

RUNOFF WATER QUALITY FROM FRESH MINE SPOIL

Brown, K.W. Environmental Pollution, Series B; Chemical and Physical; 8: No. 2, 119-131(1984).

Fresh spoil was collected from 5 sites above lignite deposits in the US Gulf Coast lignite belt. It was packed in boxes and subjected to 7 simulated 1 hour rains of 8.9 cm each, with about 20 days between rains. Run-off was analyzed for pH, electrical conductivity, Fe, Mn and sediment load. pH decreased after 60 days but did not fall below pH 5. Electrical conductivity values indicated a low salt content. Fe and Mn values were low. The sediment content was very high and it was suggested that this should be reduced prior to discharge to streams.

RUNOFF AND EROSION RESPONSE OF RECLAIMED SURFACE

Agricultural Research Service, Fort Collins, CO., D. M. Hartley. Journal of Hydraulic Engineering, Vol. 110, No. 9 p 1181-1199, September, 1984. 4 Fig., 10 Tab, 17 Ref.

Descriptors: *Land reclamation, *Erosion control, *Runoff, *Model studies, Rainfall, Precipitation, Soil loss, Computers, Strip mines, Land reclamation, Soil control.

A method for characterizing the runoff and erosion behavior of reclaimed surfaces is described and demonstrated using data from a surface coal mine. The method used data from simulated rainfall tests to calibrate or estimate parameters in a long term soil water balance model and a single event water and sediment routing model. Distributed parameter model simulation provide realistic comparisons of reclamation options because they explicitly treat local precipitation characteristics and represent the responses of different treatments based on their respective infiltration, hydraulic, and soil erodibility characteristics. After parameter values have been estimated, soil loss and runoff comparisons for a range of precipitation and topographic conditions are easily obtained. A simulation of the responses of four different surface treatments to five different first years of historical precipitation from the study area indicates substantial differences between the treatments. Predicted soil losses are low for all treatments at moderate topographic conditions. At more extreme topographic conditions, these difference appear to take on greater significance. The simulation study demonstrates the dominance of infrequent, intense precipitation events in causing the bulk of soil losses. This points out the need to establish treatment features such as mulching rates, contour furrows and surface gradients based on design storms of a given frequency rather than average annual events. The simulation technique illustrated can be used to make comparison of alternate treatments. (Baker-IVI).
W85-02449

RUNOFF WATER QUALITY FROM FRESH MINE SPOIL

Texas A and M Univ., College Station. Dept. of Soil and Crop Sciences, K. W. Brown, J. C. Thomas, and K. W. Launius. Environmental Pollution (Series B), Vol. 8, No. 2, p. 119-131, 1984. 7 Fig., 1 Tab, 14 Ref. Bureau of Mines grant J0295016.

Descriptors: *Water quality, *Water pollution sources, *Mine wastes, *Runoff, Lignite, Iron, Manganese, Sediment load.

The pH of runoff from simulated spoil piles remained between 6 and 7 for 40 to 60 days and then decreased slowly as the material weathered. The lowest runoff pH value measured was 5.0. Therefore, only slight acidification of the receiving waters is anticipated within the first 141 days.

EC values of the runoff indicated no salt hazard to receiving waters. Some of the spoil materials, particularly in the Atacosa County and Grimes County locations may pose as initial salinity hazard to vegetation. Iron contents of the runoff from simulated spoil piles were low and only on one occasion exceeded 3.5 mg/liter. Manganese contents of runoff were also low. Therefore no excessive Fe or Mn additions to receiving waters are expected. The sediment content of the runoff water was very high, and all runoff from spoil piles will need to be managed to reduce sediment load prior to discharge. (Baker-IVI)
W84-02744

RUNOFF WATER QUALITY FROM FRESH MINE SPOIL

Brown, K.W.; Thomas, J.C.; Launius, K.W.. (Texas A & M Univ., College Station). Environmental Pollution, Series G: Chemical and Physical; 8: No. 2, p. 119-131 (1984).

Few data are available on the water quality of runoff from recently disturbed lignite overburden. Therefore, a glasshouse study was done using fresh spoil material from five sites above lignite deposits in the Gulf Coast lignite belt. The spoil was packed in boxes (2700 cm_2 area) and subjected to seven simulated 1-h rains of 8.9 cm each with about 20-day periods between rains. Runoff was collected and analyzed for pH, EC, Fe, Mn and sediment load. The spoils were periodically sampled and analyzed for pH and EC. Data from all materials showed a decrease in runoff water pH after 60 days. All values remained above the runoff indicated low salt content. Iron and Mn contents were also low and should not damage receiving waters. The sediment load of runoff was very high and must be reduced prior to release of the water to streams.

RUNOFF WATER QUALITY AND HYDROLOGY AT COAL-REFUSE DISPOSAL SITES IN SOUTHERN ILLINOIS

Prodan, P.F.; Mele, L.M.; Schubert, J.P. (Argonne National Lab., IL (USA)). 1982. Contract W-31-109-ENG-38. 19 p. NTIS MF 401. Order Number DE83009687. From symposium on surface mining hydrology, sedimentology, and reclamations; Lexington, KY, USA (1 Nov 1982). Microfiche only, copy does not permit paper copy reproduction.

Data on water quality and other hydrologic parameters were gathered from runoff at three abandoned, unreclaimed, coal-refuse disposal sites in southern Illinois. Two of the sites were subsequently recontoured, limed, covered with 30 cm of glacial till and loses, fertilized, and seeded. Data collected one to four years after reconstruction of these sites indicated that (1) runoff rates were increased because the soil cover was less permeable than the coal refuse and (2) acidity, sulfate, and metal concentrations in surface runoff waters were greatly reduced following renovation. However, gradual increases in acidity, sulfate, and metal concentrations in runoff water at one for these sites were seen two years after reconstruction, and these concentrations may continue to rise in the future. This indicates that the pyrite and iron sulfate salts in the coal refuse will make reclamation a gradual and long-term process, rather than one that can be carried out quickly by grading, liming, and covering with soil. 2 tables.

STATISTICAL ANALYSIS AND EVALUATION OF WATER-QUALITY DATA FOR SELECTED STREAMS IN THE COAL AREA OF EAST-CENTRAL MONTANA

Geological Survey, Helena, MT. Water Resources Div. J. H. Lambing. Available from the OFSS, USGS, Box 25425, Fed. Ctr. Denver, CO 80225. USGS Water-Resources Investigations Report 83-4224, 1983. 89 p., 15 Fig., 8 Tab, 29 Ref.

Descriptors: *Water quality, *Statistical analysis, Regression, Flow duration, *Sediment load, Sediment yield, *Dissolved solids, *Montana, Fort Union coal region.

To document and evaluate existing conditions of water quality prior to proposed coal development in east-central Montana, water-quality data were collected at 23 sites on selected streams from October 1975 through September 1981. The data were statistically summarized and regression equations were developed to define relationships between water-quality variables. Where applicable, measured water-quality conditions were compared to various water-use standards. Measured concentrations of dissolved solids ranged from 145 to 12,200 milligrams per liter. Concentrations commonly exceeded 1,000 milligrams per liter and thereby present a high to very high salinity hazard for irrigation. Streamflow of the area contains predominantly sodium and sulfate ions and generally constitutes a medium to very high sodium hazard for irrigation during base flow. The water in most streams is generally adequate for livestock consumption during base flow. Concentrations of suspended sediment were extremely variable and had a direct correlation to water discharge. Measured suspended-sediment concentrations ranged from 4 to 23,000 milligrams per liter. Sediment-transport curves were developed for 18 of the study sites. Mean annual suspended-sediment loads were determined at five sites using the flow-duration, sediment-transport curve method. Mean annual sediment loads ranged from 1,010 to 72,7000 tons. (USGS)
W84-01770

STREAM WATER QUALITY IN THE COAL REGION OF ALABAMA AND GEORGIA. GENERAL TECHNICAL REPORT (FINAL)

Dyer, K.L. (Forest Service, Broomall, PA (USA). Northeastern Forest Experiment Station). 1982. 124 p., NTIS, PC A06/MF A01.The report includes data collected in 1977-79 from 20 small streams that drain unmined watersheds and 38 that drain areas where coal has been surface mined. Measurements include common ions, alkalinity, acidity, pH, 16 trace elements, 5 nitrogen and phosphorous species, specific conductance, suspended solids, turbidity, settleable matter, water temperature, and estimated discharge.

STREAM WATER QUALITY IN THE COAL REGION OF PENNSYLVANIA. GENERAL TECHNICAL REPORT

Dyer, K.L. (Forest Service, Broomall, PA (USA). Northeastern Forest Experiment Station). 1982. 185 p., NTIS, PC A09/MF A01.

This report is a compilation of water quality data for 86 small streams sampled in 23 counties of Pennsylvania where coal is surface-mined. Twenty-nine of these streams drain unmined watersheds; 57 drain areas where coal has been surface-mined. Most of these streams were sampled at approximate monthly intervals. The water quality data from these streams are presented in this report and should help fill the need for data from small watersheds in Pennsylvania.

THE EVALUATION OF METALS AND OTHERS SUBSTANCES RELEASED INTO COAL MINE ACCRUAL WATERS ON THE WASATCH PLATEAU COAL FIELD, UTAH

Utah Water Research Lab., Logan, UT, A. J. Seierstad, V. D. Adams, V. A. Lamarra, N.J. Hoefs, and R. E. Hinchee. Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111681, Price codes: A08 in paper copy, A01 in microfiche, water Quality Series UWRL/Q-83/09, August 1983. 156 p., 30 Fig., 46 Tab, 68 Ref, 1 Append. OWRT B-210-UTAH(2), 14-34-0001-1273.

Descriptors: Coal, Coal mining, *Coal mines *Leachates, Boron, Strontium, Water pollution control, Iron, *Acid mind drainage, Alkalinity, Mercury, Suspended solids, Grease, Hardness, Filtered wastewater, *Utah, Wasatch Plateau, *Metals.

In the face of probable coal mining expansion on the Wasatch Plateau of Central Utah, threats on drinking water safety and healthy aquatic environments were examined by reviewing reports submitted by mine operators as required by the National Pollution Discharge Elimination System, measuring pollutant concentrations in mine accrual waters before and after treatment, and analyzing experimental leachates obtained by upward flow of waters (prepared to match average natural conditions) through crushed coal in laboratory columns. The reports, mine accrual waters, and leachates covered six mines, four of which continually discharged water, and two of which were collecting water internally. One sump is being used for drinking water supply. Sampling continued from April 1981 through May 1982. Constituents measured and compared with water quality criteria for drinking, irrigating, stock watering, and aquatic resources included pH, suspended solids, metals, hardness, alkalinity, and silica. Generally, the waters did not exceed toxicity criteria, and concentrations leached from crushed coal samples provided a reasonable guide to concentrations measured in the accrual waters. Boron concentrations were occasionally high enough to affect sensitive crops. Mercury seldom exceeded standards but were generally close enough to deserve special monitoring and analysis for possible environmental effects. Acidity and iron were not a problem, but total suspended solids as well as oil and grease often were. The existing treatment by gravel filtration ponds and grease skimming devices was not very effective. Overall, the results did not find a significant pollution problem, identified potential hazards, and provided more cost effective pollution control information.
W84-00028

TRACE ELEMENTS IN NORTHERN GREAT PLAINS STRIP MINE AND LIVESTOCK IMPOUNDMENT WATER

Siskiyou National Forest, Grants Pass, OR. M. T. Anderson and C. L. Hawkes. Water Resources Bulletin, Vol. 20, No. 2, p. 251-254, April, 1984. 1 Fig., 3 Tab, 20 Ref. EPA grant EPA-1AG-D-5-E764.

Descriptors: *Trace elements, *Strip mines, *Livestock ponds, *North Dakota, *South Dakota, *Wyoming, Coal, Bentonite, Cadmium, Lead, Manganese, Iron, Heavy metals.

The water from 32 strip mine water impoundments and nine livestock watering ponds in North Dakota, South Dakota, and Wyoming were analyzed for trace elements. Because of the high concentrations of trace elements in coal and bentonite clay, the possibility exists for these elements to dissolve or be suspended in the water. Strip mine ponds were not significantly higher in trace elements concentrations compared to livestock ponds. All but one of the 41 ponds sampled contained elemental concentrations that would be detrimental for livestock use or aquatic life use. Cadmium and lead were the elements most frequently in excess of water quality criteria. Lead was found in the study ponds about 35 times the median concentration of North American rivers. Manganese concentration were found to exceed iron in many ponds, which is unused in natural waters. The potential for detrimental concentrations of trace elements in pond water must be evaluated when designing land use management plans for ponds intended to be used by livestock or aquatic life. (Author's abstract).
W84-05166

TRACE METALS IN SURFACE WATER AND STREAM SEDIMENTS OF HEALY AND LIGNITE CREEK BASINS, ALASKA (USGS/WRI-83-4173)

Parks, B. (Geological Survey, Anchorage, AK (USA)). 1983. 31 p. US Geological Survey, Box 25425, Federal Center, Denver, CO 80225. File Number T185901271.

Coal has been strip-mined in the Healy and Lignite Creek basins of the Nenana coal field. Trace metals concentrations are low in Healy Creek, but are higher in the Lignite Creek basin. Concentrations of trace metals increase as Healy Creek and Sanderson Creek (in the Lignite basin) flow past mined areas, but effects of coal mining cannot be distinguished from those due to a change in lithology or coal outcrop burning. Metals are typically concentrated on the suspended sediment. The source of the trace metals on sediment and in the water is probably the fine-grained Tertiary rock of the coal-bearing group. Local coals do not contain high levels of trace metals. Concentrations of dissolved and suspended trace metals in water and total-recoverable trace metals in the bed material do not present an environmental hazard in the Healy and Lignite Creek basins at this time. Mining does not appear to have had any appreciable effect on the quality of ground water in the basins. 14 references, 8 tables.

WATER HANDBOOK FOR METAL MINING OPERATIONS

Colorado School of Mines, Golden, CO, Dept. of Chemistry and Geochemistry. R. Wildeman. Available from the National Technical Information Service, Springfield, VA 22161 as PB84-159755, Price codes: A05 in paper copy, A01 in microfiche, Colorado Water Resources Research Institute, Fort Collins, Completion Report No. 113, November, 1981, 84 p., 11 Fig., 4 Tab, 50 Ref., 2 Append. Project No. OWRT A-034-COLO (5), Contract/Grant No. 14-34-0001-6006.

Descriptor: Water quality control, *Mine drainage, Water analysis, *Metal mines, *Colorado, Front Range, Mining, *Chemical analysis, *Pollutant identification, Effluents, Weathering, *Water quality standards.

This is a handbook that operators of metal mines can use to understand how the various substances originate in mine water and what can be done to eliminate or control their occurrence. The introductory chapters review the chemical weathering reactions of rock forming and ore minerals, and the environmental standards that apply to drinking water and mining and milling effluents. Then there is a discussion of how various physical factors such as ore petrology, groundwater hydrology, and type of ore occurrence can affect the quality of mine drainages. This chapter is based on extensive investigations of mine drainages within the Front Range of Colorado. A plan for analysis of mine waters that emphasizes understanding the chemical nature of the water is established. Finally, suggestions for water maintenance are made based on the chemistry of the water and the analysis schedules. An apppendix is a manual of common methods of analysis which emphasizes how to conduct successful tests in the environment of a mining operation.
W84-04233

HIGHWAY RUNOFF

ACUTE TOXICITY AND CHEMICAL CHARACTERISTICS OF MODERATELY POLLUTED RUNOFF FROM HIGHWAYS

Norsh Treteknisk Inst., Oslo. E. Gjessing, E. Lygren, S. Anderson, L. Berglind, and G. Carlberg. Science of the Total Environment, Vol. 33, p. 225-232, February, 1984. 7 Fig., 1 Tab, 2 Ref.

Descriptors: *Runoff, *Highways, *Toxicity, Water pollution effects, Organic compounds, Polychlorinated biphenyls, Chemical analysis, Water analysis, Bacteria, Fish, Algae, Fungi, Hydrocarbons.

Runoff from a highway has been characterized by physical, chemical and biological methods. Several organic micropollutants have been identified, such as PAH's, PCB, and other chlorinated constituents. The biological methods include toxicity tests on salmon, algae, bacteria, and fungi. Studies on the hatching of salmon eggs in the sedimented part of the highway runoff are also included. Approximately ⅓ of the dissolved organic matter and ⅔ of the organic matter that was connected to the particulates were found to be extractable with organic solvents. Only a fraction of this is, however, identified. The sample contained organic chlorine in the range of 100 micrograms Cl/1. The identified chloro-organic matter can, however, explain only a few percent of the organic chlorine in the sample. Acute toxicity tests did not show any negative effects on growth or behavior for bacteria, fungi, protozoa, algae, fish and fish eggs. The heterotrophic organisms were clearly stimulated by the runoff water, the algae were stimulated in their growth rate with rather high concentration and neither the fish eggs nor the 1 year old salmon appeared to be affected by undiluted runoff water. Apparently the pollutants are associated with particulate matter and the total amount of available organic and inorganics are moderate. None of the tests on acute toxicity suggest any negative effect. It is essential to note that chronic effects and the bioaccumulation potential have not been evaluated. (Baker-IVI)
W85-00745

EFFECT OF HIGHWAY RUNOFF ON LAKE WATER QUALITY

Norsk Treteknisk Inst., Oslo. E. Gjessing, E. Lygren, L. Berglind, T. Gulbrandsen, and R. Skaane. Science of the Total Environment, Vol. 33, p. 245-257, February, 1984. 5 Fig., 9 Tab, 5 Ref.

Descriptors: *Highways, *Runoff, *Water pollution sources, *Oslo, *Norway, Snowmelt, Stormwater, Lead, Cadmium, Zinc, Polycyclic aromatic hydrocarbons, Organic compounds, Hydrocarbons.

A small lake close to a main highway in the Oslo area has been studied with regard to water quality. The contribution of pollutants from the surrounding area, from the local atmosphere, and directly from the pavement has been studied and related to the quality of the lake water and the outflowing water. PAH's, heavy metals, and several other quality parameters are evaluated. Studies of lead, cadmium, zinc, and PAH in sediments and bottom organisms are included. The water analyses, including most relevant drinking water parameters, suggest that the contributary brooks to a relatively moderate extent are affected by inorganic highway traffic pollutants, whereas organic pollutants and suspended matter are noticeably high; the washout water from the pavement is rich in inorganic and organic pollutants and suspended matter; the lake acts as a sink most of the year for important pollutants; and the water is significantly affected by chlorides from the road salt. The snow analyses show that during the winter a considerable amount of the pollutants are deposited within 5 m of the road side; that the pollutants are also transported a considerable distance through the air, being traced in the snow even at a distance of 300 m from the highway; and that the concentrations of the inorganic micropollutants in the snow on the lake are more than 10 times higher than in the lake water itself. The sediment analyses show a significant effect on the heavy metal concentration in the upper 2 cm of the sediments, and that these are distributed all over the lake, with a possible maximum in the deeper parts; and that the enrichment of Pb, Zn, and Cd relative to normal is 2-4 fold. The adsorption studies indicate that an essential part of the PAH's in the drainage water from highway pavement is retained in the soil surface layer. In general the results suggest that important pollutants probably are strongly related to the particulate matter (dust) which is transported through the atmosphere over long distances. (Baker-IVI)
W85-00747

EFFECT OF RURAL HIGHWAY RUNOFF ON STREAM BENTHIC MACROINVERTEBRATES

Smith, M.E.; Kaster, J. L. (Univ. of Wisconsin, Milwaukee, WI). Environmental Pollution, Series A: Ecological and Biological; 32: No. 3, p. 157-170 (1983).

The impact of rural highway runoff on benthic macroinvertebrate abundance and composition was studied in a southeastern Wisconsin stream during 1980-81. The study suggests minimal effect on stream macroimvertebrates by rural highway runoff from roadways of 7000-8000 vehicles per day traffic volume. Differences in mean annual numbers and biomass between the control (4155 m^{-2}, 10.5gm^{-2}) and the station receiving slight highway runoff (2611 m^{-2}, 5.2gm^{-2}), presumably resulted from slower current and siltation at the latter. The station which received the greatest amount of runoff had higher mean annual numbers (13,291 m^{-2}) and biomass (62.2gm^{-2}) than the control. Increased current and better substratum were probably responsible for masking potential highway effects at this station. Another station with intermediate amounts of highway runoff had similar annual mean numbers (4642 m^{-2}) and biomass (10.6gm^{-2}) to the control. Similar values for richness were found between stations. Pollution sensitive fauna were approximately half as abundant at the station with intermediate amounts of highway runoff, suggesting possible slight runoff influence.

EFFECT OF RURAL HIGHWAY RUNOFF ON STREAM BENTHIC MACROINVERTEBRATES

Wisconsin Univ. — Milwaukee, WI, Dept of Zoology.M. E. Smith, and J. L. Kaster. Environmental Pollution (Series A), Vol. 32, No. 3, p. 157-170, 1983. 3 Fig, 4 Tab, 21 Ref.

Descriptors: *Highway effects, *Runoff, *Invertebrates, Stream pollution, Water pollution effects, Biomass, Abundance, Benthos, Wisconsin.

The impact of rural highway runoff on benthic macroinvertebrate abundance and composition was studied in a southeastern Wisconsin, USA, stream during 1980-81. The study suggests minimal effect on stream macroinvertebrates by rural highway runoff from roadways of 7000-8000 vehicles per day traffic volume. Differences in mean annual numbers and biomass between the control (4155/sq m, 10.5 g/sq m) and the station receiving slight highway runoff (2611/sq m, 5.2 g/sq m), presumably resulted from slower current and siltation at the latter. The station which received the greatest amount of runoff had higher mean annual numbers (13291/sq m) and biomass (62.2 g/sq m) than the control. Increased current and better substratum were probably responsible for masking potential highway effects at this station. Another station with intermediate amounts of highway runoff had similar annual mean numbers (4642/sq m) and biomass (10.6 g/sq m) to the control. Similar values for richness were found between stations. Pollution sensitive fauna were approximately half as abundant at the station with intermediate amounts of highway runoff, suggesting possible slight runoff influence. (Author's abstract)
W84-02784

FATE OF HEAVY METALS IN STORMWATER RUNOFF FROM HIGHWAY BRIDGES

University of Central Florida, Orlando, Dept. of Civil Engineering and Environmental Science. Y. A. Yousef, M. P. Wanielista, T. Hvitved-Jacobsen, and H. H. Harper. Science of the Total Environment, Vol. 33, p. 233-244, February, 1984. 3 Fig., 7 Tab, 11 Ref.

Descriptors: *Storm water, *Runoff, *Highways, Florida, Scupper drains, Drainage, Metals, Heavy metals, Percolation, Overland flow, Water pollution control.

Pollutants associated with runoff water from highway bridges located in Central Florida were characterized and quantified. These pollutants are directly discharged through scupper drains to adjacent water bodies and flood plains or detained in ponds before being released to lakes and streams. Runoff water contains heavy metals such as lead, zinc, copper, chromium, iron, nickel and cadmium which concentrate in adjacent soils and biota. Most of the heavy metals released to a lake were concentrated by bottom sediments. On a mass balance basis which estimated the average distribution of heavy metals per unit area between the dissolved fraction, suspended fraction and bottom sediments, most of the heavy metals were associated with the bottom sediments, typically 95-98% of the total. High concentrations of heavy metals in submerged plants and benthic organisms were detected. When highways pass over water bodies, especially landlocked impoundments where the effects of heavy meal pollution are more localized and high traffic volumes are encountered, it is recommended that the use of scupper drains in new construction be limited as much as is feasibly possible. Runoff from the ridge surface should be directed off the ridge surface toward either side so that the runoff will experience the maximum overland flow to encourage percolation and removal of heavy metals before reaching the receiving body. (Baker-IVI)
W85-00746

FATE OF PHOSPHORUS AND NITROGEN IN PONDS RECEIVING HIGHWAY RUNOFF

Aalborg Universitetscenter (Denmark). Dept. of Civil Engineering. T. Hvitved-Jacobsen, Y. A. Yousef, M. P. Wanielista, and D. B. Pearce. Science of the Total Environment, Vol. 33, p. 259-270, February, 1984. 10 Fig., 3 Tab, 11 Ref.

Descriptors: *Phosphorus, *Nitrogen, *Highways, *Runoff, *Ponds, Water pollution sources, Water quality, Nutrients, Fate of pollutants, Water quality control.

The fate of phosphorous and nitrogen was investigated in detention/retention ponds receiving highway runoff. Investigations comprising loading, quality and isolation chamber studies have been carried out in a 1.2 ha shallow pond located in central Florida. Transformation and exchange rates for nutrients across the water sediment interface have been determined. About 99% of the total input of phosphorus during 7 years has accumulated in the sediments. Furthermore, 85-90% of the total nitrogen input has been removed probably by denitrification. Also, in situ experiments demonstrated the importance of the sediment as a sink for both phosphorus and nitrogen. Even though the pond is subjected to high areal loading of both phosphorus and nitrogen a high water and sediment quality is obtained as a result of good nutrient removal efficiencies. Maintenance of a permanent oxidized sediment layer of some depth is a key factor. Therefore, a shallow pond with sediments dominated by inorganic matter, providing good oxygen conditions at the water sediment interface, seem to be important parts of future quality design criteria for these ponds. (Baker-IVI)
W85-00748

INFLUENCE OF HIGHWAY CONSTRUCTION ON THE MACROINVERTEBRATES AND EPILITHIC ALGAE OF A HIGH MOUNTAIN STREAM

Colorado State Univ., Fort Collins, CO, Dept. of Zoology and Entomology. L. D. Cline, R. A. Short, and J. V. Ward. Hydrobiologia, Vol. 96, No. 2, p. 149-159, October, 1982. 9 Fig., 5 Tab, 29 Ref.

Descriptors: *Highway construction, *Invertebrates, *Algae, *Mountain streams, Suspended solids, Species diversity, Snowmelt, Construction, Water pollution effects, Organic matter, Detritus, Hydrological regime, Epilithon.

The response of a high elevation Rocky Mountain stream to highway construction activities was investigated over a three-year period during the ice-free season. Suspended solids and the proportion of fine sediment in the substrate increased at impacted sites, but rapidly returned to levels similar to reference sites following cessation of construction activities. During snowmelt runoff when suspended solids levels increased, there was little or no sedimentation of fine particles, even in depositional areas. At impacted sites algal species diversity and the organic content of the epilithon were reduced, and the detrital component was increased. The epilithon recovered less rapidly than suspended solids or substrate. The macroinvertebrate community was altered by construction activities at some locations but not others, and was generally less severely affected than anticipated. However, where an alteration occurred, reduction density, abundance, and diversity were apparent, and the taxomic composition was modified. The severity of the response was a function of the flow regime and the timing and duration of the impact at a given site. The hydrologic regime and high gradient of the study stream appeared to ameliorate to some extent the potentially adverse effects of short-term perturbations engendered by highway construction activities. (Author's abstract)
W85-01470

MANAGEMENT OF DRAINAGE SYSTEMS FROM HIGHWAY BRIDGES FOR POLLUTION CONTROL

Y. A. Yousef, M. P. Wanielista, H. H. Harper, and E. Christopher. Transportation Research Record, No. 896, p. 51-55, 1983. 2 Fig., 5 Tab, 11 Ref.

Descriptors: *Highway effects, *Bridges, *Runoff, Cadmium, Heavy metals, Lead, Zinc, Copper, Chromium, Iron, Nickel, Drains, Sediments, Floodplains, Drainage systems, Lake Ivanhoe, Orlando, Florida.

Pollutants associated with runoff water from highway bridges were characterized and quantified. These pollutants are directly discharged through scupper drains to adjacent water bodies and floodplains or detained in ponds before being released to lakes and streams. Selected heavy metals, such as lead, zinc, copper, chromium, iron, nickel, and cadmium, were of particular concern because of their potential enrichment in biota. Results show significant differences in heavy metal concentrations between water samples from bridge runoff and adjacent streams. Heavy metals tend to concentrate in bottom sediments, floodplains, and adjacent soils. For example, bottom sediment samples from Lake Ivanhoe, north of Orlando, Florida, collected beneath bridges with scupper drains showed significantly higher concentrations of heavy metals than did samples collected beneath bridges without scupper drains. In addition, concentration of heavy metals in the sediments of detention ponds receiving bridge drainage were higher than concentrations in sediments from adjacent lakes. It appears that management and careful design consideration of highway bridge drainage systems could result in significant reduction of the amount of pollutants released to adjacent water bodies (Author's abstract)
W84-02227

POLLUTANT LOADING MODEL FOR HIGHWAY RUNOFF

Systems Architects Engineers, Inc., Seattle, WA. T. W. Chui, B. W. Mar, and R. R. Horner. Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 108, No. EE6, p. 1193-1210, December, 1982. 4 Fig., 11 Tab, 24 Ref.

Descriptors: *Water pollution sources, *Fate of pollutants, *Storm runoff, Model studies, *Pollution load, *Highway effects, Storm water, Urban runoff, Storms, Pollutants, Environmental effects, Suspended solids, *Washington.

Data from composite sampling of about 500 storm events at nine locations in Washington State were used to formulate a stormwater runoff pollutant loading model to describe the mechanisms of highway and traffic pollution of stormwater runoff. The model incorporates an expression relating total suspended solids (TSS) load to motor vehicle traffic, runoff coefficient, and surrounding land use contributions. Other contaminants such as volatile suspended solids, chemical oxygen demand, total organic carbon, total Kjeldahl nitrogen, nitrate, nitrite, total phosphorus, copper, zinc and lead are estimated from TSS load using load ratios derived from the data. These ratios may be taken as constants at any Washington state location for some pollutants or as a linear function of traffic volume for others. The model is useful in forecasting cumulative pollutant loadings in runoff from highways constructed in locations where climatic, soil, and land use conditions are similar to those at the sampling sites used to construct the data base. It is capable of predicting loadings over a time span encompassing a number of storms, but has little precision when applied to individual storm events. (Geiger-FRC)
W83-03829

PREDICTION OF STORM-INDUCED SEDIMENT YIELD FROM HIGHWAY CONSTRUCTION

L. M. Younkin and G. B. Connelly. Transportation Research Record, Vol. 832, p. 1-6, 1981. 3 Fig., 3 Tab, 14 Ref.

Descriptors: *Prediction, *Mathematical models, *Soil erosion, *Sediment yield, *Storm runoff, *Highway effects, * Road construction, Model studies, Erosion, Sediment transport, Stream erosion, Mathematical equations, Environmental effects.

A mathematical model was developed for predicting storm-induced increases in suspended sediment yield in a stream system due to highway construction. A prediction equation was formulated by regression analysis of data collected at nine stream-gage sites in five watersheds in Pennsylvania. The analysis emcompassed 278 data sets. The model relates factors describing soil erodibility, rainfall, construction phases and proximity to the construction site to the increased quantity of sediment transported. Results show that the amount of sediment transported increases with soil erodibility, storm-erosion index, area cleared and grubbed, cut-and-fell heights, and proximity of construction to the stream. The standard error of the final form of the equation was large, although not exceptional when compared with the results of other sediment-transport studies. The equation may be used as a tool in highway location studies, evaluation of highway development impact, and design of sediment catchment devices. (Geiger-FRC)
W83-01832

QUANTIFICATION OF ACCUMULATED LOADS ON ROAD SURFACES AND THEIR RUNOFF CHARACTERISTICS

Kansai Univ., Osaka (Japan). Dept. of Civil Engineering. Y. Wada and H. Miura. Water Science and Technology, Vol. 16, No. 5-7, p. 463-472, 1984. 5 Fig., 5 Tab, 3 Ref.

Descriptors: *Mathematical models, *Roads, *Street sweeping, *Water pollution sources, Simulation, Nonpoint pollution sources, Pollution load, Storm runoff, Urban areas.

Pollutants caused by urban activities accumulate in the environment, and the accumulated pollution loads are flushed out from road surfaces and conveyed directly to the receiving waters. The quantity of accumulated load on the road surfaces, the composition and local distribution of accumulated load, and how these loads are flushed out by rainfall must be studied in order to provide information for use in the reduction of nonpoint-pollution loads. A model was developed for the accumulated loads on road surfaces. The accumulated load on road surfaces shows large differences among each area and is flushed out in greater quantities at a comparatively early stage in rainfall. The accumulated loads on road surfaces are much influenced by the frequency and efficiency of road surface cleaning. If the cleaning is carried out every three days, the runoff loads decrease by 4/9 to 3/7 of the load without cleaning. This method can be used to simulate the runoff accumulated loads on road surfaces, and to obtain useful information on the prevention of water quality deterioration. (Moore-IVI)
W85-01421

THE CHARACTER AND DISPERSAL OF MOTORWAY RUN-OFF WATER

Victoria Univ. of Manchester (England). Pollution Research Unit. E. G. Bellinger, A. D. Jones, and J. Tinker. Water Pollution Control, Vol. 81, No. 3, p. 372-390, 1982. 7 Fig., 6 Tab, 49 Ref.

Descriptors: *Highways, *Storm water, * Deicers, Water pollution sources, Fate of pollutants, Roads, Sodium, Chlorides, Nitrates, Runoff, Rainstorms, Water quality, Suspended sediments, Groundwater pollution.

Surface water runoff and sediment deposits from a 680 m stretch of the Blackpool Link section of a motorway in England were monitored after selected rainstorms from January 1976 to December 1977. Peak monthly concentrations of Na, Mg, Ca, nitrate, sulfate, and Cl were highest during winter, reflecting the use of road deicing salts. Residence time of rock salt on the road surface was less than 3 weeks. Routine analysis of groundwater samples in the aquifer beneath a brook receiving runoff showed increases in Ca, Mg, C1, nitrate, and sulfate starting a few months before the official opening to traffic in July 1975. Sediment particle size was well-graded in the 0.1-2 mm size range (medium and coarse sand). Chemical analysis of suspended solids showed an association of chemical ions with the smaller sediment particles. Concentrations of ions (mg per liter) during non-salting periods were: K and Mg, < 5; Ca, 30-100; Na, 12-37; sulfate 6-100; Cl, 22-75; and nitrate, 1.95-73.5. Nitrate was not affected by road salting but was influenced by farming activities. However, maximum concentrations (mg per liter) of the other ions were reached during salt application: K, 47; Mg, 42; Ca, 820; Na, 20,000; and Cl, 37,500. The first flush from a storm usually contained the highest levels of pollutants. The pollutant load was a function of antecedent dry days and quantity of rainfall. Pollution loads (in kg) per storm discharged into the receiving stream were: Na, 0.064-1025; K, 0.017-0.967; Ca, 0.087-21.02; Mg, 0.013-1.833; sulfate, 0.039-20.85; nitrate, 0.058-1.18; chloride, 0.83-11.95 and suspended solids, 0.06-43.65. Storm runoff contributed up to 78% of ionic contaminants and up to 48% of the suspended solids leaving the roadway and entering the brook. An undetermined amount of poluted road water was dispersed to the atmosphere as dry particles or spray. (Cassar-FRC)
W83-00461

WATER QUALITY OF LAKES FAITH, HOPE, CHARITY, AND LUCIEN, 1971-79, IN AN AREA OF RESIDENTIAL DEVELOPMENT AND HIGHWAY CONSTRUCTION AT MAITLAND, FLORIDA

Geological Survey, Tallahassee, FL. Water Resources Div. E. R. German. USGS Water-Resources Investigations Report 82-51, 1983. 71 p., 18 Fig., 18 Tab, 14 Ref.

Descriptors: *Water quality, *Lakes, Runoff, Precipitation, *Florida, Orange County, Seminole County, Maitland.

Lakes Faith, Hope, and Charity were sampled from April 1971 to June 1979 to monitor water quality before, during, and after construction of Maitland Boulevard and the Interstate Highway 4 interchange. Lake Lucien was add-

ed to the study in April 1975. Chemical quality of the lakes varies little in comparison with surface runoff, bulk precipitation, and the water in the surficial aquifer. Surface runoff supplied about 19 percent of the direct inflow to the lakes and contributed a total of about 2,000 pounds, per acre of lake surface, of dissolved solids from April 1971 to June 1979, while bulk precipitation contributed about 1,170 pounds per acre. Water quality in the lakes changed during the study, generally for the better. However, an infestation of elodea (hydrilla verticillata), whose growth is not associated with water quality, developed in Lake Hope near the end of the study and has interfered with recreational use of the lake. (USGS)
W84-03596

WATER QUALITY OF MOTORWAY RUNOFF. SUPPLEMENTARY REPORT (PB-84-201052)

Colwill, D. M.; Peters, C. J.; Perry, R. (Transport and Road Research Lab., Crowthorne (UK)). 1984. 28 p. NTIS, PC E04/MF E04.

Measurements of the concentration of various water quality parameters in road-surface runoff have been made at an experimental catchment on the M1 motorway near Toddington, Bedfordshire. The amounts of particulate material and associated contaminant removed from the road surface by individual events are largely dictated by the intensity of rainfall and the total volume discharged. Seasonal differences in water quality are directly related to de-icing activities; in winter, salt is the principal constituent of runoff. During dry periods, vehicle generated air turbulence is considered to be an important pathway for the removal of material from the carriageway. As well as these more obvious qualitative findings quantitative information on pollutant loadings is also presented. Surface runoff on motorways is estimated to yield 1500 kg/km year of suspended solids, 4 kg/km year of lead, 126 kg/km of oil and 18 g/km year of polynuclear aromatic hydrocarbons.

WATER-QUALITY ASSESSMENT OF STORM—WATER RUNOFF FROM A HEAVILY USED URBAN HIGHWAY BRIDGE IN MIAMI, FLORIDA

Geological Survey, Tallahassee, FL., Water Resources Div. D. J. McKenzie and G. A. Irwin. Available from OFSS, USGS, Box 25425, Fed. Ctr., Denver, CO 80225. USGS Water-Resources Investigations Report 83-4153, 1983. 45 p., 15 Fig., 3 Tab, 20 Ref.

Descriptors: *Water quality, *Storm runoff, *Highway effects, * Florida, Miami.

Runoff from a heavily-traveled, 1.43-acre bridge section of Interstate-95 in Miami, Florida, was comprehensively monitored for both quality and quantity during five selected storms between November 1979 and May 1981. For most water-quality parameters, 6 to 11 samples were collected during each of the 5 runoff events. Concentrations of most parameters in the runoff were quite variable both during individual storm events and among the five storm events; however, the ranges in parameter concentration were about the same magnitude report for numerous other highway and urban drainages. Data were normalized to estimate the average, discharge-weighted parameter loads per storm per acre of bridge surface and results suggested that the most significant factor influencing stormwater loads was parameter concentration. Rainfall intensity and runoff volume, however, influenced rates of loading. The total number of antecedent dry days and traffic volume did not appear to be conspicuously related to either runoff concentrations or loads. (USGS)
W85-00841

YEAR 3 — RUNOFF WATER QUALITY, AUGUST 1979—AUGUST 1980. INTERIM REPORT (PB-83-171496)

Mar, B. W.; Ferguson, J. F.; Welch, E. B. (Washington State Dept. of Transportation, Olympia (USA). Public transportation and Planning Div.; Washington Univ., Seattle (USA). Dept. of Civil Engineering). Jan 1981. 25 p. NTIS, PC A02/MF A01.

This report summarizes findings detailed in Report Nos. 4 and 5 plus the work of Zawlocki on trace organics in highway runoff. Several hundred compounds tentatively, identified by GC-MS were grouped into nine categories, which were not mutually exclusive. Major components of these categories were petroleum products used by vehicles and incompletely combusted hydrocarbons. The concentrations of these trace organics groups were low compared to criteria proposed for protection of aquatic life.

BEST MANAGEMENT PRACTICES (BMPs)

EFFECTIVENESS OF STREET SWEEPING IN URBAN RUNOFF POLLUTION CONTROL

Illinois State Water Survey Div., Champaign. G. M. Bender, and M. L. Terstrep. Science of the Total Environment Vol. 33, p. 185-192, February, 1984, 5 Fig., 2 Tab, 2 Ref.

Descriptors: *Street sweeping. *Water pollution control, *Urban runoff, *Champaign, *Illinois, Storm runoff, Metals, Nutrients, Particle size.

In March 1982, the Illinois State Water Survey completed a three-year study for the Illinois Environmental Protection Agency to determine the effects of municipal street sweeping on urban storm runoff quality. The project was part of the Nationwide Urban Runoff Program sponsored by the U.S. Environmental Protection Agency. In Champaign, Illinois, four urban drainage basins featuring separate sewers and ranging in size from 16 to 55 acres (6.5-22.3 ha) were instrumented for runoff event monitoring and sampling. Data collection included recording of precipitations and storm runoff and sampling of runoff and atmospheric fallout. A telemetry system was developed and installed to link the remote sampling sites to a minicomputer, which automatically controlled the collection and storage of data and the instruction for sampling. During 1980 and 1981, samples were collected and analyzed for total concentrations of solids, metals, and nutrients for 90 events. A street dirt sampling program designed to measure the total loads of material on the streets was conducted over the same period. Determinations were made of the particle size distributions and constituent concentrations in the street loads. Municipal street sweeping at different frequencies was practiced on the basins during the monitoring period. The procedures used in data collection and the results obtained from the sampling programs are presented and discussed. For the conditions monitored, street sweeping is shown to be ineffective as a management practice for urban storm runoff quality control. (Author's abstract)
W85-00744

EFFECTS OF CHANNEL EXCAVATION ON WATER-QUALITY CHARACTERISTICS OF THE BLACK RIVER AND ON GROUND-WATER LEVELS NEAR DUNN, NORTH CAROLINA

Geological Survey, Raleigh, NC. Water resources Div. C. E. Simmons, and S. A. Watkins. Available from the OFSS, USGS, Box 25425, Fed. Ctr. Denver, CO 80225, USGS Water-Resources Investigations Report 82-4083, 1982. 28 p., 15 Fig., 4 Tab, 9 Ref.

Descriptors: *Channel improvement, *Water quality, *Groundwater levels, *North Carolina, Chemical analyses, Bank storage, Suspended sediment, Nutrients, Dissolved solids, Streamflow characteristics, Black River, Channelized streams, Watertable wells, Mean concentrations, Channel alterations.

During 1976-81 data were collected at three sites on the Black River near Dunn, N.C., to define the effects of channel excavation on stream quality and on ground-water levels in nearby areas. One of the data sites was located upstream from the five-mile long excavated reach and served as a background station. Changes in various characteristics of this Coastal Plain stream were determined by comparing data collected before, during, and after the construction period. After deepening of the channel by more than 2 feet, ground-water levels within 100 feet of the stream declined a proportionate amount; however, levels in a well 500 feet from the stream were unchanged. Flow velocities during channel deepening were 100 percent higher than velocities prior to construction. An average increase in water temperatures of about one degree Celsius was observed following removal of trees and brush that provided shading to the stream. After construction, concentrations of dissolved oxygen also increased. The percent of saturation increased 20 to 25 percent in the lower values. Maximum concentrations of suspended sediment increased from about 75 mg/L prior to construction to over 2000 mg/L during construction. Within a year after construction, levels of suspended sediment during stormflow had decreased but remained 5 to 10 times greater than preconstruction levels. Little or no change occurred in pH, total-dissolved solids, nitrogen, phosphorus, and bacteria. (USGS)
W85-01924

EVALUATION OF DESIGN CRITERIA FOR SEDIMENT DETENTION BASINS IN SURFACE MINING

Tiyamani, C. Blacksburg, VA, USA; Virginia Polytechnic Inst. and State Univ. (1983). 348 p. University Microfilms Order No. 83-02,811. Thesis (Ph. D.).

A modeling procedure was developed to simulate daily soil loss from surface mining activities. The model parameters were assigned daily values to index the effect of temporal and spatial variability during the mining operation. A first order Markov chain and the Monte Carlo simulation method was used to generate daily rainfall sequences. These data were reduced to hourly increments using a Pearson type II distribution. The SCS runoff curve number procedure was used to predict surface runoff. Soil loss was estimated with the MUSLE equation, the Puls method was used to route flow through the sediment detention pond. Trapping efficiency was based on a procedure developed from Stoke's law. The performance of four detention pond designs with storage capacities ranging from approximately 9 ac-ft to 2 ac-ft were evaluated. Two revegetation plans and two soil types with different particle size distributions were simulated. Mining start times of January 1, February 1, and April 1 were used to illustrate seasonal variations. The simulation results suggest that effluent guidelines alone give a poor estimate of the magnitude of sediment leaving the mine site through a detention pond. Despite low annual sediment loss the monthly mean concentration of total suspended solids seldom met the regulatory guidelines of 35 mg/l. The monthly average effluent concentration of total suspended solids was 1550 mg/l when the sediment loss was only 0.2 ton/acre. Additionally, the results suggest that with good management the size of detention ponds can be significantly reduced. The modeling methodology also provides a procedure to generate an information base that can be used to evaluate the risks associated with using a given pond design.

IN-SITU DENITRIFICATION OF PONDS

Napier J. M. (Oak Ridge Y-12 Plant, TN (USA)). 1 Nov 1984. Contract AC05-84OS21400. 7 p. (CONF-841187-2). NTIS, PC A02/MF A01; GPO Dep. File Number DE85002620.

From 5. DOE environmental protection information meeting; Albuquerque, NM, USA (6 Nov 1984).

An in-situ biological denitrification process successfully reduced nitrate ion concentrations in four 2.5 million gallon open-air holding ponds from nearly 40,000 mg/L to less than 50 mg/L. Concurrently, heavy metal concentrations were reduced to levels acceptable for discharge. 3 figures.

MANAGEMENT AND CONTROL TECHNOLOGY FOR URBAN STORMWATER POLLUTION

Santa Clara Univ., CA. Dept of Civil Engineering. E. J. Finnemore, and W. G. Lynard. Journal of the Water Pollution Control Federation, Vol. 54, No. 7, p. 1099-1111, July, 1982. 5 Fig., 7 Tab, 36 Ref.

Descriptors: *Storm water, *Urban runoff, *Combined sewer overflows, *Water pollution control, Runoff, Vegetation, Reviews, Erosion control, Slope stabilization, Detention reservoirs, Sedimentation, Water storage, Storage, Planning, Land use, Cost analysis, Nonstructural alternatives.

Urban storm water management practices were summarized including approaches for managing and controlling pollution from urban runoff and combined sewer overflow. Best management practices (BMP), either nonstructural or low-structural, have been gaining recognition as cost-effective solutions to these problems. Nonstructural controls include institutional measures (planning and legislation), modification of maintenance practices (street cleaning), and control of development and natural land conditions to reduce runoff and pollution. Low-structural controls use natural land features with minor modifications and small simple structures to control pollution. These may be berms earthworks, and outlet devices. The most common low-structural control is detention storage, usually constructed near the source of runoff or pollution. Erosion control methods include soil stabilization (matting, mulching, chemicals, tackifiers, and slope support), runoff control (diversion dikes, interception trenches, pipe drops, chutes and flumes, sediment barriers, and berms), and vegetation. Combined sewer overflows are generally handled by structural measures. Storage is the most important element. In-line storage (flow restriction and regulation devices and pumping stations) is most cost-effective and flexible. Off-line storage, alone or combined with in-line storage, includes sedimentation/storage tanks or ponds, some of which also provide treatment. Integrated systems (combined sewer overflow controls, dry-weather treatment facilities, plus BMP) are even more cost-effective. This review discloses several deficiencies in storm water management information such as limited performance data especially for integrated systems, insufficient cost data base, less information on source control strategy than on combined sewer overflow strategy, and lack of monitoring data to support the claimed benefits for storm water abatement programs. (Cassar-FRC)
W83-00148

MEASURES TO PREVENT WATER POLLUTIONS BY CHEMICAL FERTILIZERS AND SOIL EROSION PRODUCTS

P. S. Pasternak, N. N. Prikhod'ko, V. P. Landin, and Yu. D. Matukhno. Water Resources, Vol 9, No. 4, 0 409-415, July-August, 1982. 6 Tab, 12 Ref. Translated X from Vodnye Resursy, No. 4, p. 128-135, July-August, 1982.

Descriptors: *Groundwater pollution, *Fertilizers, *Erosion control, Organic compounds, Urea, Ammonium nitrate, Superphosphate, Manure, Nitrophoska, Phosphorus, Potassium, Reforestation, Water pollution control.

Part of the fertilizers applied to croplands enters water bodies with the surface and subsurface runoff and affects the chemical composition and quality of natural waters. Modern agricultural techniques have become one of the greatest contributors of biogenic elements (BE) to the water system. A study of the effect of various forms and rates of chemical fertilizers on the quality of surface runoff plots from croplands was carried out in model experiments with sugar beets set up with fourfold replication. The most common fertilizers used were studied including ammonium nitrate, urea, granulated superphosphate, manure salts, and nitrophoska at rates of 60, 90, and 180 ka/ha of the active ingredient. Fertilizers were applied in the spring during topdressing of the crops. An additional 30 kg/ha each of phosphorus and potassium were applied on the plot in the autumn for fall plowing. It was established that the level of pollution of the runoff waters and soil erosion products depends on the type of crop being cultivated, method and time of applying the fertilizers, and the intensity of the development of the erosion process. Positive effects of shelterbelts and afforestation on the composition of the surface runoff entering from fields is confirmed by special investigations on experimental drainage basins with a different degree of afforestation and also on combined runoff plots. Runoff-purifying tree stands simultaneously perform water-regulating and erosion control functions and therefore when creating and siting them on drainage basins it is necessary to be guided by the recommendations

developed for shelterbelts and plantings having water regulating and erosion control purposes. (Baker-IVI)
W84-02324

NONPOINT POLLUTION CONTROL FOR RANGELAND WINTERING LIVESTOCK OPERATIONS (GROUND COVER)

Idaho Univ., Moscow. Coll. of Engineering. J. E. Dixon, A. J. Lingg, D. V. Naylor, D. D. Hinman, and G. R. Stephenson. Available from the National Technical Information Service, Springfield, VA 22161 as PB83-108563, Price codes: A03 in paper copy, A01 in microfiche. Idaho Water and Energy Resources Research Institute, Completion Report, Idaho University, Moscow, June, 1982. 21 p., 2 Fig., 14 Tab., 4 Ref., 1 Append. OWRT A-064-IDA(1), 14-34-0001-0114.

Descriptors: *Nonpoint pollution sources, *Pollution load, *Livestock, *Stream pollution, *Irrigation effects, Cattle, Grasses, Alfalfa, Streams, Range grasses, Rocky Mountains, Stochastic process, Runoff, Analysis of variance, Mathematical studies, Water analysis, Pollutant identification.

An investigation was made of stream-side cattle winter holding areas as potential sources of nonpoint-water pollution. Mass balance calculations were made for each of various measured constituents, based on irrigation inflow, runoff, and constituent concentrations. The results of these calculations quantify the pollutant loss from land wintering cattle. An analysis of variance showed no significant difference between the ground cover (hay crop) treatment means for any constituent. There was, however, a trend toward better pollutant retention with alfalfa and fescue mixture. Other grasses used with alfalfa were brome and orchard grass. The test plots were irrigated twice each year. The effect of the first versus the second irrigation was also analyzed, but no significant difference in pollutant retention was noted. Stream water samples were analyzed for ammonia, nitrate, total nitrogen and phosphorus, orthophosphate, sodium, potassium, calcium, magnesium, and chloride. Other determinations made included biological and chemical oxygen demands, dissolved oxygen, total organic carbon, suspended solids, and bacterial counts for fecal coliforms and streptococci, and for total coliforms. The data should be limited to situations involving runoff from irrigation water. It was concluded that the amount of pollutant loss to streams through irrigation return flow from land wintering cattle seems quite small. (Zielinski-MAXIMA)
W83-00252

NONPOINT SOURCE WATER POLLUTION ABATEMENT AND THE FEASIBILITY OF VOLUNTARY PROGRAMS

Wisconsin Univ. — Milwaukee. Dept. of Urban Planning. D. S. Sawicki, and L. B. Judd. Environmental Management, Vol. 7, No. 5, p. 453-464, 2 Fig., 5 Tab, 13 Ref.

Descriptors: *Nonpoint pollution sources, *Water pollution control, *Voluntary programs, Decentralization, Institutional constraints, Urban areas, Rural areas, Root River watershed, Illinois.

A voluntary, decentralized institutional arrangement for nonpoint source water pollution control used in the root River watershed in southeastern Wisconsin was studied in order to monitor and draw conclusions about the effectiveness of a voluntary, decentralized institutional system, to specify deficiencies of the approach and suggest means to correct them, and to use the conclusions to speculate about the need for regulations regarding nonpoint source pollution control or the appropriateness of financial incentives for nonpoint source control. This watershed was chosen because of its mix of urban, agricultural, and urbanizing land uses. Institutional factors considered include diversity of land uses in the watershed, educational needs, economic conditions, personality, water quality, number of agencies involved, definition off authority, and bureaucratic requirements. Fairly good progress was made toward securing cooperative agreements with landowners and committing cost share funds to implement rural nonpoint source control practices. There was little evidence that the institutional system used will result in implementation of urban runoff control practices. The decentralization used in the Root River watershed is responsible both for its degree off success and for many of the impediments to greater progress. The voluntary approach has been well received in the watershed and has been successful in committing cost-sharing money to soil-related (rural) practices. It has not resulted in commitment to practices in the priority established in the plan and offers little control over the order in which practices are implemented. Decentralization does not offer as great an advantage for urban practices, and it may have hindered progress in the Root River watershed. (Moore-IVI)
W84-02643

NUTRIENT REMOVAL FROM WASTEWATER BY WETLANDS

North Central Forest Experiment Station, Grand Rapids, MN. D. S. Nichols.
In: Proceedings, 6th International Peat Congress, August 17-23, 1980, Duluth, Minnesota, W. A. Fisher Company, Eveleth, Minnesota, 1981. p. 638-642, 2 Fig., 1 Tab. 61 Ref.

Descriptors: *Wastewater management, *Wetlands, *Nitrogen removal, *Phosphorus removal, *Nutrient removal, *Literature review, Wastewater, Water quality, Water quality control, Wastewater disposal, Wastewater discharge, Wastewater lagoons, Wastewater treatment, Phosphorus, Nitrogen, Denitrification, Ammonium, Nitrates.

The literature on the capacity of wetlands for removing nitrogen (N) and phosphorus (P) from wastewater was reviewed and assessed. Retention of inflowing P under natural conditions appears to be limited to the relatively small amount of P that is accumulated as peat is formed

from partially-decayed vegetation. Some P is absorbed by the soil when above-natural levels are added to a wetland. Wastewater P is most efficiently removed at low loading rates, and efficiency decreases rapidly as loading rates increase. Further, P removal declines with time; hence, short-term studies can give misleadingly high estimates of ultimate P removal capacity. Removal of N in excess of the natural accumulation rate in the peat is apparently by denitrification. As with P, N removal efficiency decreases rapidly as wastewater N loading rates are increased. The denitrification rate may be limited by the nitrification rate of ammonium-N, nitrate-N, or by oxygen diffusion. From the sparse literature data available, it is estimated that 1 ha of wetland would be needed to remove 75% of the P and N generated by 15 and 20 people, respectively, or to remove 54% of the P and N generated by 50 people. Hence, wetland application is feasible only where wetlands are abundant and population densities are low. Large populations cannot be served by this means. (Zielinski-MAXIMA)
W83-00226

NUTRIENT TRAPPING BY SEDIMENT DEPOSITION IN A SEASONALLY FLOODED LAKESIDE WETLAND

Wisconsin Univ. — Madison. Dept. of Soil Science. C. A. Johnston, G. D. Bubenzer, G. B. Lee, F. W. Madison, and J. R. McHenry. Journal of Environmental Quality, Vol. 13, No. 2, p. 283-290, April-June, 1984, 6 Fig., 3 Tab, 26 Ref., EPA grant R804823.

Descriptors: *Wetlands, *Sediment deposition, *Nutrients, Water quality, Soil chemistry, Nitrates, Phosphates, Flooding, Alluvium, White Clay Lake, Wisconsin.

Sediment and nutrient retention was studied in a seasonally flooded lakeside wetland as a natural mechanism for preventing water quality deterioration. Both wetland and upland soils in the watershed had comparable concentrations of inorganic P on a per-volume basis, while NH4(+)-N and organic forms of N and P were much higher in the wetland soils. Nitrate concentrations expressed in a per-volume basis were lower in the wetland soils than in the upland soils. The distribution of sediment and nutrients in the wetland was correlated with distance from a small stream flowing through the wetland. Deposition patterns were affected by recent stream channel migrations. The accumulation of nutrients and sediment delivered from the upland to wetland soils was estimated in two ways: (i) by calculating the volume of alluvium deposited in low natural levees adjacent to the stream; and (ii) by estimating nutrient and ash enrichment of histic surface soils farther away from the stream. Although the levees constituted only about 20% of the wetland surface area, they accounted for 81% of the sediment, 84% of the N, and 67% of the P retained by the wetland. The depth of Cs-137 in the soil was used to estimate net sedimentation rates. Average annual accumulations over the wetland as a whole were: 2.0 kg sediment/sq m/yr, 2.6 g P/sq m/yr, and 12.8 g N/sq m/yr. Since these values exceed those published for average annual storage by wetland plants, soil mechanisms are more important than vegetative uptake for long-term nutrient and sediment retention in the White Clay Lake wetland. (Author's abstract)
W84-05121

PHOSPHORUS REMOVAL IN A SEWAGE TREATMENT PLANT AND PLANT BIOMASS IN AN EFFLUENT RECEIVING LOWLAND STREAM

East Brabant Dept. of Technology, Boxtel (Netherlands). F. A. Kouwe. Hydrobiological Bulletin, Vol. 17, No. 2, p. 143-156, December, 1983. 8 Fig., 10 Tab, 13 Ref.

Descriptors: *Aquatic weed control, *Wastewater treatment, *Phosphorus removal, *Beerze, *Netherlands, Macrophytes, Aquatic weeks, Biomass, Streams, Streamflow.

The possibility of controlling plant growth by lowering the phosphorus concentration of the stream water through phosphorus removal in a sewage treatment plant was investigated. Biomass development, the role of the sediment, the natural phosphate concentration of streams, the phosphorus, nitrogen and potassium content of plants were studied. Decreasing the phosphorus concentration in the lowland stream Beerze by means of P-reduction with ferrosulfate in the sewage treatment plant Hapert did not lead to a decrease in biomass of aquatic macrophytes in this stream. To achieve a substantial decrease in the production of plant biomass by lowering the P-concentration of the water more measures are needed than P-reduction in sewage treatment plants only. Measures should be taken to reduce or possibly even to eliminate the influence by agricultural activities and stormwater overflows as well as the removal of nutrient rich sediments. (Baker-IVI)
W84-04378

RUNOFF FROM UTILITY WASTE LANDFILL TO BE RECYCLED FROM DETENTION BASIN TO SCRUBBER MAKE-UP

Johns Hopkins Univ., Laurel, MD Applied Physics Lab.J. J. Lentz. Industrial Water Engineering, Vol. 20, No. 1, p. 8-17, January/February, 1983. 3 Fig., 5 Tab, 11 Ref. Maryland Power Plant Sitting Program Contract P1-81-03.

Descriptors: *Runoff, *Settling basins, *Waste disposal, *Vienna, *Maryland, Landfills, Fly ash, Sludge disposal, Powerplants, Heavy metals, Dissolved solids, Calcium, Sulfates.

Runoff from the working face of a proposed landfill for blended fly ash and scrubber sludge at a Vienna, Maryland powerplant will be captured in a lined retention basin and used for 7 to 10% of total scrubber make-up needs in order to prevent escape of heavy metals and high total dissolved solids, mostly calcium and sulfate ions, into the sensitive surface water and ground water of the Delmarva Peninsula. The effectiveness of a runoff detention basin was investigated using 30 years of daily temperature and precipita-

tion data to simulate continuing operation of the basin and make-up system under a variety of assumptions and alternate operation rules. The number of potential overflows which might be calculated in most highly sensitive to the assumed runoff coefficient. The runoff coefficient will not be a constant, but will vary directly with the degree to which the surface becomes saturated during a precipitation event. The system is sensitive to the rate at which make-up is withdrawn. Although the number of overflows during 3- or 6-week shutdown periods showed increases, the quantities of runoff spilled remained small. While the number of spills varied greatly as a function of both runoff coefficient and withdrawal rate, with careful matching of facilities design and operation to expected demand, a basin designed to hold contaminated runoff for recycling represents a workable approach to the management of an otherwise serious waste disposal problem. (Baker-IVI)
W85-01849

SEDIMENT RETENTION EFFICIENCY OF SYNTHETIC FILTER FABRICS

Pennsylvania State Univ., University Park. Dept. of Agricultural Engineering. L. S. Fisher, and A. R. Jarrett. Transactions of the ASAE, Vol. 27, No. 2, p. 429-436, March-April, 1984. 14 Fig., 6 Tab, 17 Ref.

Descriptors: *Erosion, *Subsurface drainage, *Filters, *Sediment retention, Soil filters, Suspended solids, Suspended load, Sand, Silt, Clay.

Improved land management practices are needed to reduce the excessive erosion resulting from rapidly changing land use. Several researchers have successfully used synthetic filter fabrics as soil retention barriers in subsurface drainage applications. Hence, synthetic filter fabrics have the potential to remove suspended soil particles resulting from erosion. Six synthetic filter fabrics were investigated for particle retention and water transmissibility when subjected to a flowing soil suspension. Four replicate tests were performed with sand, coarse silt, and silt-clay soil suspensions. All fabrics successfully removed sand particles (>75 micro m) from suspension. Various amounts of coarse silt particles (75 to 37 micro m) were removed by the fabrics tested and these filter fabrics were generally ineffective filters of silt clay particles (<37 micro m). When significant quantities of soil particles were retained, filter clogging reduced each fabric's ability to transmit water. A definite compromise exists between a filter fabric's ability to remove soil particles while transmitting water flow. (Author's abstract)
W85-01189

SEDIMENT TRAP EFFICIENCY OF A SMALL RESERVOIR

Agricultural Research Service, Oxford, MS. Sedimentation Lab. F. E. Dendy, and C. M. Cooper. Journal of soil and Water Conservation, Vol. 39, No. 4, p. 278-280, July/August, 1984. 7 Fig., 1 Tab, 5 Ref.

Descriptors: *Sedimentation, *Reservoirs, *Sediment traps, *Mississippi, Silt, Sediments, Clay, Storm runoff, Sediment load.

The amount of sediment trapped in a reservoir depends upon the quantity of inflowing sediment and the sediment trapping efficiency of the structure. The sediment trap efficiency of a 2.7 acre reservoir in the northern Mississippi's Goodwin Creek drainage basin was measured during a 2 yr period. While the overall trap efficiency was about 77%, monthly trap efficiencies ranged from 9% to 10%. Trap efficiency was generally much higher for storms accompanied by high sediment loads and high sediment concentrations. Trap efficiency was generally low for storms producing low sediment concentrations. High variable flow detention times may explain part of the variation in storm trap efficiencies. Although the overall sediment trap efficiency of small reservoirs may be relatively high, short-term and individual storm trap efficiencies may vary widely. A much greater proportion of the inflowing sediment is trapped from storms with high sediment loads and high sediment concentrations. Average flow detention time in small reservoirs may vary from a few hours to a few days. (Baker-IVI)
W85-03352

SIMPLIFYING STORMWATER DETENTION BASIN DISCHARGE CONTROL DETERMINATIONS

Rockaway Township Water Dept., NJ. R. J. McKinnon. Public Works, Vol. 115, No. 6, p. 68-69, June, 1984. 1 Fig.

Descriptors: *Storm runoff, *Detention reservoirs, *Basins, Design criteria, Mathematical equations, Outlet discharge, Flow routing.

To comply with the demand for better control of storm drainage, engineers are resorting to the use of stormwater detention basins that will permit controlled discharge of excess flows into existing wasteway systems. Discharge control is a vital part of the system. The procedure for dimensioning and sizing of detention facilities must necessarily begin with an inflow hydrograph based on available data and the determination of the quantity of outlet discharge allowed by existing facilities, natural constraints, and/or legal requirements. It is then necessary to route the typical storm through the basin. Two additional critical elements are needed to complete the design: the shape and size of the basin and the outlet control mechanism. The outlet control for small basins is typically a circular storm sewer pipe with a headwall. In attempting to simplify the solution of selecting a pipe size for a particular headwater depth, the empirical data from the nomograph were correlated with existing theory and used to develop readily usable mathematical formulas. (Baker-IVI)
W85-00735

SOIL LOSS REDUCTIONS FROM CONSERVATION TILLAGE PRACTICES

Universidade Federal do Rio Grande do Sul, Porto Alegre (Brazil). N. P. Cogo, W. C. Moldenhauer, and G. R. Foster. Soil Science Society of America Journal, Vol. 48, No. 2, p. 368-373, March-April, 1984. 7 Tab, 18 Ref.

Descriptors: *Soil erosion, *Conservation tillage, *Soil management, Erosion control, Mulches, Martinsville loam, Hapludalfs, Russell silt loam soil, Simulated rainfall, Soil conservation.

Conservation tillage practices are the least costly and least disruptive of the presently available erosion control systems, and in many cases lead to a very significant saving in energy and other expenses. Soil loss reductions by residue cover (mulch) under field conditions were verified by deriving a mulch factor for no-till, chisel plowing plus disking, and spring sweep tillage using anchored and unanchored corn (Zea mays L.) and soybean (Glycine max (L.) Merr.) residues on a 4.5% slope 10.5 m long on Russell silt loam soil. A mulch factor was also derived for sweep tillage using anchored wheat residue on a 6.5% slope Martinsville loam soil, for simulated slope lengths of 35, 60, 85, 110, and 135 m. Both soils are Typic Hapludalfs. The studies were conducted using simulated rainfall and field plots. A crop residue mulch was relatively more effective than roughness alone in reducing soil loss on smoother soil surfaces and on the longer slopes. Corn residue was more effective in reducing erosion than soybean residue, and residues partially incorporated into the soil were more effective in reducing soil loss than residues loose on the surface. The findings showed that the b-value in the mulch factor (Fm) % residue cover (M) equation Fm = e to the negative bM power varied appreciably depending on roughness, and type and incorporation of the residue. (Murphy-IVI)
W84-04878

SOIL, WATER AND NUTRIENT CONSERVATION BY CERTAIN RIPARIAN HERBS

Banaras Hindu Univ., Varanasi (India). Centre for Advanced Study in Botany. R. S. Ambasht, M. P. Singh, and E. Sharma. Journal of Environmental Management, Vol. 18, No. 2, p. 99-104, March, 1984, 3 Tab, 3 Ref.

Descriptors: *Riparian vegetation, *Riparian land, *River Gomti, *India, *Erosion control, Nutrient removal, Soil conservation, Water conservation, Organic carbon, Nitrogen, Soil porosity.

In the Indian plains, the dense human population prevents permanent afforestation of riparian ecosystems, ideally, afforestation would stabilize the system and check erosion and river meandering. In order to assess the quantitative roles of herbaceous plants in binding the soil, nutrient conservation and retarding water runoff and soil erosion, six species dominant on the banks of the River Gomti at Jaunpur (India) were selected and planted on sloping experimental plots in the Botanic Garden, Banaras Hindu University. Propagules of the following dominant rainy season species were selected: Cynodon dactylon, Phyla nodiflora, Cyperus rotundus, Croton bonplandianum, Crotalaria medicaginea, and Digitaria adscendens. Known quantities of water were sprayed on vegetated and bare plots, and runoff water and soil were collected in separate cemented reservoirs. The soil conservation value of selected grasses and sedge was found to range from 87.6 to 95.4%, and of dicotyledon weeds from 52.8 to 93.8%. The plants retarded water runoff by about 60%, compared with the bare plot. Water conservation values for herbaceous cover, compared with the bare plot values, ranged from 65 to 74% for grasses and sedge, and 27 to 72% for dicotyledon weeds. Organic carbon and nitrogen content were conserved and soil porosity and waterholding capacity were improved by C. dactylon, P. nodiflora, C. rotundus, and D. adscendens. (Collier-IVI)
W85-01156

STORM WATER DETENTION/RETENTION: A NEW SOLUTION

Advanced drainage Systems, Inc., Columbus, OH. J. B. Goddard. Public Works, Vol. 115, No. 6, p. 82-83, June, 1984. 3 Fig., 2 Tab.

Descriptors: *Storm runoff, *Drainage, *North Myrtle Beach, *South Carolina, Design criteria, Runoff management, Water storage, Runoff, Storms, Erosion control, Saline water intrusion.

The management of storm water in rapidly developing areas has become a major concern in many communities. Without adequate storm water facilities, the runoff rate following storms may create substantial erosion and increase the possibility of downstream flooding. City ordinances are currently being or have recently been established in many communities to regulate the disposal of future development projects. Government agencies who regulate the preservation of sensitive coastal areas, the South Carolina Coastal Council, the Army Corps of Engineers, and the city engineer, studied various solutions that had been applied in similar situations in other communities to solve a problem being experienced in North Myrtle Beach, South Carolina. The solution appears to be the installation of a perforated drainage pipe at a number of locations to deal with storm water disposal and storage. Storm water is temporarily stored and then released and cleaned as it percolates into sandy soils. The pipe is installed in trenches and surrounded by a gravel backfill, which in turn is lined with a filler fabric to prevent sand or soil seepage into the stone bed. The system is particularly suited to coarse, sandy soil types. In coastal areas this method can also help negate the effects of salt water intrusion into aquifers. Use of the perforated pipe system in North Myrtle Beach has been successful and allows for conventional building and site planning. (Baker-IVI)
W85-00737

STORMWATER POLLUTION CONTROL: BEST MANAGEMENT PRACTICES

Santa Clara Univ., CA. Dept. of Civil Engineering. E. J. Finnemore. Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 108, No. EE5, p. 835-851, October 1982. 1 Fig., 2 Tab, 24 Ref.

Descriptors: *Water pollution control, *Storm runoff, Storm wastewater, Water pollution sources, Street cleaning, Heavy metals, Suspended solids, Sediment transport, Erosion, Erosion control, California, Cost analysis, Maryland, Urban runoff, Management, Washington.

Case studies are presented which describe four instances in which successful and very promising best management practices (BMPs) were employed for nonstructural and elementary structural storm-water pollution control. Their approaches, implementation, and resulting performance, costs and impacts are described for the use of planners and designers. In Bellevue, Washington, an innovative stormwater utility has effectively administered Bellevue's stormwater management program. In a regional approach at Montgomery County, Maryland, many source controls have minimized erosion and removed most pollution from urban runoff at moderate costs. Near Lake Tahoe, in California, planning for stormwater management aided by erosion controls has prevented tremendous increases in sediment yields. At San Jose, California, extensive studies revealed that improved street cleaning will effectively control total solids and heavy metals in runoff. (Baker-FRC)
W83-01941

STORMWATER QUALITY CHARACTERISTICS IN DETENTION BASINS

Princeton Univ., NJ, Dept. of Civil Engineering. R. A. Ferrara, and P. Witkowski. Journal of Environmental Engineering, Vol. 109, No. 2, p. 428-447, April, 1983. 10 Fig., 7 Tab, 14 Ref.

Descriptors: *Storm water, *Detention reservoirs, *Water pollution control, Particle size, Chemical oxygen demand, Phosphorus, Nitrogen, Effluents, Sedimentation.

The use of stormwater detention basins for the dual purpose of flood control and mitigation of pollutant runoff loads has been promoted. However, only limited data and methods of analysis and prediction of pollutant removal in detention basins exist. This paper presents the results of a stormwater quality sampling program conducted to describe the particle size distribution and the time variable influent and effluent concentrations of chemical oxygen demand (COD), total phosphorus, total kjeldahl nitrogen (TKN), and solids during various storm events. Concentrations in three separate particle size ranges for each of the four parameters was determined. The basin is shown to be generally effective in reducing solids, COD, and total phosphorus. TKN concentrations and loadings were generally increased. The effectiveness of the detention basin in reducing pollutant loads appears to be related to two factors, namely equalization and sedimentation. Dry weather water quality in the detention basin determines the importance of the former, whereas the particle size distribution for each pollutant determines the degree of sedimentation. (Author's abstract)
W84-01108

STORMWATER RUNOFF TREATMENT BY IMPOUNDMENT; BARRHAVEN PILOT STUDY

Ottawa-Carleton Regional Municipality (Ontario). Works Depart. R. J. Gieta. Report SCAT-8, 1981. 72 p., 36 Fig., 12 Tab, 8 Ref., 2 Append.

Descriptors: *Storm water, *Storm wastewater, *Storm runoff, *Rainfall-Runoff relationships, *Wastewater treatment, Runoff, Impoundments, Storm-overflow sewers, Runoff coefficient, Runoff volume, Rainfall, Suspended solids, Bacteria, Nutrient removal, Runoff rates, Mathematical studies, Water treatment.

A 2-year study was conducted on stormwater runoff treatment by impoundment in an open basin, with the treatment system operated as a batch process for one summer and as a continuously-overflowing pond for another. Impoundment reduced pollutant loadings by over 90% for suspended solids, 75-90% for bacteria (total and fecal coliforms, and fecal streptococcus), and 25-50% for organic nitrogen and total phosphorus compounds when the runoff could be stored for over 12 hours. At least 5 mm of rainfall were needed to produce measureable runoff. Runoff/rainfall ratios estimated the runoff volumes that would be generated by up to 25-year return frequency storms off 1- and 2-hour durations. From this, a storage volume of 40,000-47,000 cu m was indicated, on the basis of runoff containment from a 10-year storm. The most effective treatment system operating method was to keep the reservoir drawn down to a shallow pond. When runoff entered the pond, the drain valve was closed and the treatment system filled. If possible, runoff volume was contained until quality was suitable for discharge. When effluent quality became satisfactory, the reservoir was drained to the original shallow pond and dry weather flow allowed to pass through. Allowing one day to fill and one day for storage, the reservoir should require two days to empty. (Zielinski-MAXIMA)
W83-0083

STREET SWEEPING AS A WATER POLLUTION CONTROL MEASURE: LESSONS LEARNED OVER THE PAST TEN YEARS

Woodward-Clyde Consultants, San Francisco, CA. J. D. Sartor, and D. R. Gaboury. Science of the Total Environment, Vol. 33, p. 171-183, February, 1984. 3 Fig., 5 Tab, 14 Ref.

Descriptors: *Street sweeping, *Water pollution control, Water pollution sources, Path of pollutants, Urban runoff, Water quality management, Lead, Pollution load.

Street surfaces are both sources of urban runoff pollutants and pathways for the transport of pollutants originating from adjacent land areas. This view has led to the suggestion that street sweeping may be a valuable best management practice (BMP) for the control of urban runoff quality. Initial investigations beginning in the early 1970's indicated that changes in street sweeping practices could be beneficial in reducing urban runoff pollution. In response to this early research, the U.S. Environmental Protection Agency sponsored Nationwide Urban Runoff Program adopted a broad-based assessment of street sweeping as one of its central research elements. The key finding of street sweeping research to date is that as a general, broad-based water quality best management practice it does not appear to be effective in reducing end-of-pipe urban runoff pollution loads. Under favorable conditions, reduction of about 30% can be expected, but more typical performance is in the 10 to 30% range. For certain constituents such as lead, where street surfaces are the overwhelming sources, street sweeping can control well of 50% of the loads. There are other specific conditions where street sweeping can be effective. (Author's abstract)
W85-00743

USE OF ARTIFICIAL WETLANDS TO REMOVE NITROGEN COMPOUNDS FROM WASTEWATER

Ecological research Associates, Davis, CA. R. M. Gersberg, C. R. Goldman, and B. V. Elkins. Aqua, No. 6, p. 492-496, 1982. 4 Tab, 4 Ref.

Descriptors: *Wastewater treatment, *Nitrogen, *Nitrate, *Artificial wetlands, Wetlands, Bacteria, Biological treatment, Biological wastewater treatment.

The deleterious effects of nitrogen on both surface and groundwater supplies have led to a significant increase in research focused on the development of cost-effective and energy-efficient nitrogen removal process. Our investigations at Santee, California, have demonstrated the exceptional utility of artificial wetlands (800 sq m) for the removal of nitrate from nitrified secondary wastewaters at relatively high application rates. The major loss of nitrogen from these wetland systems was due to bacterial denitrification. When no carbon source was added to other marsh beds to supplement the carbon supply and fuel the denitrification process, nitrogen removal in the artificial wetlands was relatively low (8%). However, when the artificial marsh beds were amended with methanol, mean removal of TN (total nitrogen) was 94% at an application rate of 20 cm per day. Since artificial wetlands provide an ideal environment for photosynthetic carbon fixation as well as denitrification, we tested the efficacy of using plant biomass, mulched and applied to the surface of the artificial marsh beds, as an alternate and low-cost source of carbon. In mulch-amended beds the mean removal efficiencies were 70% for the TN and 77% for TIN (total inorganic nitrogen) at an application rate of 20 cm per day. Rising operational and energy costs make biological systems such as artificial wetlands very attractive as low-cost, low-energy systems for removal of nitrogen from municipal and agricultural wastewaters and contaminated groundwater supplies. (Author's abstract)
W85-01978

BIOLOGICAL

A THRESHOLD CONCEPT OF ENVIRONMENTAL POLLUTANTS

Institute of Hygiene, Gera (German, D. R.). Dept. of Toxicology. R. Koch. Chemosphere, Vol. 12, No. 1, p. 17-21, 1983. 1 Tab, 10 Ref.

Descriptors: Water pollution effects, *Toxicity, Chemical reactions, Environmental effects, Public health, Mutagenesis, Carcinogenesis, Teratogensis, Classification.

At present, toxicological data such as the acute toxicity, toxicokinetics, toxicodynamics in subchronic exposure, carcinogenicity, mutagenicity, and teratogenicity are basic elements in thresholds concepts. However, biochemical and animal experimentations needed to obtain the data are limited for several reasons. Theoretical considerations are needed for establishing a generally usable threshold concept. It is important to distinguish exactly between the terms dose or concentration and exposure as well as to define the meaning of the term "threshold". While relationships between structure, physicochemical properties and chemical reactivity as well as biological activity are well known in molecular toxicology, it is important to note that a chemical reaction between an exogenous compound and a biological macromolecule in target tissue, organs or cells is a fundamental aspect of many biological activities and toxicity reactions. The kinetic, thermodynamic and structure-activity relationships imply that a threshold level exists, depending on different chemical structure parameters which govern absorption, distribution, bioconcentration and excretion processes; and the activation energy of a biochemical reaction and the temperature, which govern both the number of reactive molecules and the reaction rates. The application of thermodynamic, kinetic and quantum mechanic regularities as well as structure-activity relationships suggests that the single molecule causing biological effect is an unacceptable concept. (Baker-FRC)
W83-04057

ACUTE TOXICITY OF LEACHATES FROM COAL GASIFICATION AND LIQUEFACTION SOLID WASTES IN THE FATHEAD MINNOW, PIMEPHALES PROMELAS

Suloway, J. J.: Schuller, R.M.: Griffin, R. A. (Ill State Nat Hist Surv., Champaign). Journal of Environment Science and Health, Part A: Environmental Science and Engineering: A16:No. 4, 419-445 (1981).

Ninety-six hour static bioassays were conducted with one-to-six-day-old fathead minnow fry to determine the acute toxicity of leachates generated from Lurgi gasification ashes, an H-coal liquefaction residue and an SRC-I liquefaction residue. LC-50 values, their 95% confidence intervals and the amount of dilution necessary to eliminate mortality during the 96-hour bioassays were determined. Leachates that were generated from the solid wastes at four pH levels and under anaerobic and aerobic conditions were analyzed for approximately 40 chemical constituents. Nineteen of the constituents were found to exceed recommended water quality criteria levels in some of the samples of pH values between 2.3 and 11.3. All leachates with a pH less than 6.2 were acutely toxic and required at least a 1:10 dilution and as much as a 1:2000 dilution to eliminate mortality. 28 refs.

AGRICULTURE AND STREAM WATER QUALITY: A BIOLOGICAL EVALUATION OF EROSION CONTROL PRACTICES

North Carolina Dept. of Natural Resources and Community Development, Raleigh, N.C. D. R. Lenat. Environmental Management, Vol. 8, No. 4, p. 333-344, July, 1984, 10 Tab, 31 Ref.

Descriptors: *North Carolina, *Water quality, *Erosion control, *Ecological effects, *Agricultural runoff, Benthos, Aquatic insects, Sedimentation, Water pollution effects, Caddisflies, Mayflies, Stoneflies.

Agricultural runoff affects many streams in North Carolina. However, there is little information about either its effect on stream biota or any potential mitigation by erosion control practices. In this study, benthic macroinvertebrates were sampled in three different geographic areas of North Carolina, comparing control watersheds with well-managed and poorly managed watersheds. Agricultural streams were characterized by lower taxa richness (especially for intolerant groups) and stability. These effects were most evident at the poorly managed sites. Sedimentation was the apparent major problem, but some changes at agricultural sites implied water quality problems. The group most intolerant of agricultural runoff were Ephemeroptera, Plecoptera and Trichoptera. Tolerant species were usually filter-feeders or algal grazers, suggesting a modification of the food web by addition of particulate organic matter and nutrients. This study clearly indicates that agricultural runoff can severely impact stream biota. However, this impact can be greatly mitigated by currently recommended erosion control practices. (Author's abstract)
W85-02296

AN ASSESSMENT OF MARINE POLLUTION IN PUGET SOUND

National Oceanic and Atmospheric Administration, Seattle, WA. Office of Marine Pollution Assessment. E. R. Long, Marine Pollution Bulletin, Vol. 13, No. 11, p. 380-383, 1982. 1 Fig.

Descriptors: *Organic compounds, *Metals, *Marine animals, Fate of pollutants, Puget Sound, Washington, Aromatic hydrocarbons, Water pollution effects, Fish, Pesticides, Chlorinated hydrocarbons, Marine Ecosystems Analysis Report, *Washington.

Selected results of the Marine Ecosystems Analysis Puget Sound project, initiated in 1978, are reported. Routinely analyzed were 27 aromatic hydrocarbons, 13 chlorinated pesticides, 37 metals, polychlorinated biphenyls (PCB), and chlorobutadines in sediments and organisms. The highest mean contaminant levels in sediments and sole livers, respectively, were: PCB, 380 ppb and 35,000 ppb; total chlorobutadienes, 1600 ppb and 9100 ppb; hexachlorobenzene, 74 ppb and 3700 ppb. Total aromatic hydrocarbons levels reached a high of 13,000 ppb (mean value). Highest trace metals concentrations were: Hg, 1900 ppb; Pb, 630,000 ppb; As, 470,000 ppb; and Cd, 18,000 ppb. A large variety of histopathological conditions were observed among fish, shrimp, and crabs collected in the most heavily polluted sites, Elliott and Commencement Bays, near the urban centers of Tacoma and Seattle. Species compositions of marine fauna also reflected the pollution levels. Findings of this study show that the marine resources of Puget Sound, perceived as clean by consumers, are highly contaminated by toxic chemicals in some areas (Cassar-FRC)
W84-00159

ANALYSIS OF AQUATIC TOXICITY DATA: WATER SOLUBILITY AND ACUTE LC50 FISH DATA

W. B. Neely. Chemosphere, Vol. 13, No. 7, p. 813-819, 1984. 1 Fig., 2 Tab, 15 Ref.

Descriptors: *Organic compounds, *Solubility, *Fish, *Toxicity, Water pollution effects.

A theoretical relation has been established between the water solubility of an organic chemical and the ratio of the acute fish LC50 at two different time periods. The theory was tested by examining a data base of 24 chemicals. The finding of a positive correlation between the observed and calculated ratio of the 96 hr LC50 to the 24 hr LC50 helped to substantiate the theory. In addition to indicating a procedure for reducing LC50 values to a common time interval, the study has identified two groups of chemicals. If a chemical is soluble to the extent of 100 micrograms/L or less and possess a low toxicity, then 96 hrs will not be long enough to accumulate a toxic dose. Examples are the chlorinated biphenyls, where the earliest time to achieve a 50% kill has been shown to be 12 days. Spillage of such a chemical would be no immediate concern from an acute point of view, as the spill will disperse much faster than the chemical can accumulate in the organism, causing the critical concentration to never be reached. The second group are the more soluble materials, which would have a high probability of acccumulating in the organism in a very short period of time. If the agent was sufficiently toxic then a partial kill might result from a spill. Such categorization allows an investigator to make some early decisions on the potential problems resulting from the release of a chemical into an aquatic environment. (Baker-IVI)
W85-01966

AQUATIC BIOLOGY IN NEDERLO CREEK, SOUTHWESTERN WISCONSIN

Geological Survey, Madison, WI. Water Resources Div. P. A. Kammerer, Jr., R. A. Lidwin, J. W. Mason, and R. P. Narf. Available from the National Technical Information Service, Springfield, VA 22161 as PB82-257577, Price codes: A03 in paper copy, A01 in microfiche. Geological Survey Water-Resources Investigations 82-56, November 1982. 27 p., 6 Fig., 10 Tab, 20 Ref.

Descriptors: *Small watersheds, *Water quality, *Ecosystems, *Aquatic life, Benthic fauna, Aquatic plants, Algae, Aquatic insects, Trout, Spawning, Aquatic environment, *Wisconsin, Nederlo Creek, Driftless area.

This report presents the results of biological investigations made during a study of hydrology and water quality in a small drainage basin in the "Driftless Area" of southwest Wisconsin. The aquatic community is diverse and reasonably stable with little indication of environmental disturbance. Aquatic macrophyte population (dominated by Ranunculus aquatilis L, Veronica catenata Penn., and Nasturtium officinale) varies little from spring to fall. Periphytic and planktonic algae are predominantly diatoms, with the genus Achnanthes dominating both communities. Most genera of plankton algae originate in the periphyton, but some true planktonic algae were identified. The benthic invertebrate population is dominated by Trichoptera. Biotic index values calculated from benthic invertebrate data indicate that water quality is very good to excellent. The trout population is low and represents only a small part of the total fish population both in biomass and numbers. The most important environmental factors limiting trout population appear to be lack of sufficient cover, insufficient pool depth and volume, and limited spawning areas. The wild trout population is highly dependent on spawning success; when spawning success was poor, populations the following fall were extremely low. (USGS)
W83-02978

AQUATIC TOXICOLOGY AND HAZARD ASSESSMENT, PROCEEDINGS OF THE ANNUAL SYMPOSIUM ON AQUATIC TOXICOLOGY, 4TH, 1979

Branson, D. R.; Dickson, D. L. (eds). Philadelphia, PA; American Society of Testing Materials (1981).471p. (CONF-7910273 –).

From 4. Annual symposium on aquatic toxicology; Chicago, IL, USA (16 Oct 1979).

The conference proceedings contains 32 papers, of which two are indexed separately. The focus is on the idea that hazard assessment is an estimate of the margin of safety between an exposure concentration and a no-observable-adverse-effect concentration in any given aquatic environment. The following types of topics are discussed: safety margins, hazard assessment, carcinogenesis of aquatic organisms, monitoring, statistical analysis of toxicity data, and new concepts.

CHEMICAL POLLUTANTS IN SEDIMENTS AND DISEASES OF BOTTOM-DWELLING FISH IN PUGET SOUND, WASHINGTON

Malins, D.C.; McCain, B.B.; Brown, D.W.; Chan, S.L.; Myers, M.S.; Landahl, J.T.; Prohaska, P.G.; Friedman, A.J.; Rhodes, L.D.; Burrows, D.G. (National Marine Fisheries Service, Seattle, Washington). Environmental Science and Technology; 18: No. 9, p. 705-713 (Sep 1984).

A 4-year multidisciplinary study was conducted on relationships between pollutants and diseases of fish in Puget Sound, WA. In this study, high concentrations of a large number of anthropogenic chemicals such as petroleum hydrocarbons, polychlorinated biphenyls (PCBs) and other chlorinated compounds, pesticides, and metals were found in certain Puget Sound sediments. For example, over 900 individual organic compounds were detected in sediment from one urban bay (Commencement Bay), and evidence was obtained for the presence of numerous additonal compounds. Many of the chemicals accumulated in bottom-dwelling fish, and high levels of certain toxic chemicals in urban bays were linked to serious diseases (e.g., liver carcinomas) of English sole (parophyrys vetulus) and other demersal fish species. It was concluded that application of the approach used would reveal comparable serious pollution-related health problems in marine biota in other urban coastal areas of the world.

CLOSTRIDIUM PERFRINGENS AS AN INDICATOR OF STREAM WATER QUALITY

Hawaii Univ., Honolulu. Water Resources Research Center. R. S. Fujioka and L. Shizumura. Available from the National Technical Information Service, Springfield, VA 22161 as PB83-265066, Price codes: A03 in paper copy, A01 in microfiche. Technical Report No. 154, June 1983. 37 p., 3 Fig., 12 Tab, 16 Ref. OWRT A-087-HI(1), 14-34-0001-1113.

Descriptors: *Bacteria, *Clostridium perfringens, Water quality, Water pollution, Streams, Effluent, Indicators, *Bioindicators, *Fecal coliform, *Fecal streptococcus, Kipapa stream, Ahuimanu stream, Oahu, *Hawaii.

The mCP medium devised by Bisson and Cabelli in 1979 was used to recover Clostridium perfringens from sewage and streams. This membrane filtration method proved to be uncomplicated and reliable. Of 98 presumptively positive colonies recovered from various stream samples, 89 or 91% were confirmed as C perfringens by using biochemical tests, whereas only 1 of 29 (3%) of the presumptively negative colonies was subsequently confirmed as C perfringens. The quality of streams receiving treated and chlorinated sewage effluent was determined by analyzing the effluent entering the stream as well as stream samples and below the effluent discharge site for fecal coliform (FC), fecal streptococcus (FS), and C perfringens (CP). Chlorination was shown to drastically reduce the concentrations of FC and FS, but not CP in the sewage effluent. As a result, the concentrations of FC and FS in the chlorinated effluent were less than the natural concentrations of these bacteria in the stream, whereas the same effluent contributed significantly more CP than was naturally present in the stream. Thus, analysis of stream water for CP, but not FC or FS, clearly indicated the input of effluent into the stream. Moreover, the FC:CP ratio was useful in determining the quality and distance of a major source of pollution within a stream.
W83-03999

DIFFERENTIAL RESPONSE OF MARINE ORGANISMS TO CERTAIN METAL AND AGRICHEMICAL POLLUTANTS

Toledo Univ. OH. Dept. of Biology. H. H. Lee and C. H. Xu. Bulletin of Environmental Contamination and Toxicology, Vol. 33, No. 4, p. 460-467, October, 1984. 2 Fig., 3 Tab, 10 Ref.

Descriptors: *Water pollution effects, *Metals, *Marine animals, *Agricultural chemicals, Organic compounds, Brine shrimp, Starfish, Sea urchins, Amphioxus, Bioassay.

Oocyte maturation of the starfish, fertilization and embryogenesis of sea urchins, and the development of amphioxus and brine shrimps were used to assay the effects of several common metals and agrichemicals frequently found in the marine environment. Brine shrimp embryos were most tolerant to all the substances at the levels tested. There were no effects on their hatchability or development. The most toxic substances in affecting 1-methyladenine induction of starfish oocyte maturation were triphenyls. Cu, Mg, Ni, and Zn inhibited fertilization of sea urchin eggs as evident by the absence of fertilization membrane and cleavage. The findings of the differential response of different species and stage specific response to environmental pollutants can be used in a diversity of purposes. (Baker-IVI)
W85-02783

EFFECTS OF SEDIMENT RELEASES FROM A RESERVOIR ON STREAM MACROINVERTEBRATES

Colorado State Univ., Fort Collins. Dept. of Zoology and Entomology. L. J. Gray and J. V. Ward. Hydrobiologia, Vol. 96, No. 2, p. 177-184, October, 1982, 6 Fig., 1 Tab, 31 Ref.

Descriptors: *Guernsey Reservoir, *Wyoming, *Invertebrates, *Sediments, *Reservoir operation, Suspended solids, Particulates, Midges, Mayflies, Oligochaetes, Reservoir silting, Flushing, Benthic, fauna.

One method of increasing the useful life of reservoirs is flushing of profundal sediments. Releases of reservoir sediments are expected to adversely affect macroinvertebrates by altering substrates, increasing suspended solids, and introducing potential toxins. Effects of sediment release from Guernsey Reservoir on macroninvertebrates of the North Platte River, Wyoming, were investigated during summer 1981. Because flows from

an upstream reservoir are used to flush sediments from Guernsey Reservoir, discharge and most water quality parameters vary little from those before the flushing (silt run). Suspended solids concentrations during sediment release increased from 20 mg/l to 300 mg/l. Because fine particulates remained in suspension, mean particle size of substrates was unaltered. Densities of chironomids decreased 90% + during sediment release but recovered to initial levels in 3 weeks after the release ended. Densities of mayflies and oligochaetes increased. Changes in benthic populations were highly correlated with increases in suspended solids. In the North Platte River, sediment releases had short-term effects on benthic populations and subsequent selection for organisms with rapid life cycles. (Moore-IVI)
W85-01471

LABORATORY ASSESSMENT OF THE TOXICITY OF URBAN RUNOFF ON THE FATHEAD MINNOW (PIMEPHALES PROMELAS)

Massachusetts Univ., Amherst, MA. Dept. of Environmental Science. C. Medeiros, R. A. Coler, and E. J. Calabrese. Journal of Environmental Science and Health, Vol. A19, No. 7, p. 847-861, 1984. 2 Fig., 3 Tab, 18 Ref. Dept. of Interior, Project 126-MASS.

Descriptors: *Urban runoff, *Fathead minnows, *Toxicity, Growth, Hatching, Survival, Water pollution effects, Snowmelt, Seasonal variation.

The early life stage effects of urban runoff (rain and snowmelt) on hatching, growth and survival of the fathead minnow (Pimephales promelas) was assessed in static and flow-through systems. The data indicate a Maximum Allowable Toxicant Concentration (MATC) and a reduction of growth to 50% of controls at 28% and 60% runoff, respectively Hatchability and average lengths were not as sensitive indicators of stress as millimeters produced per treatment. The data indicate a maximum toxicity in the fall which coincided with the reported drop in macroninvertebrate diversity during the same period, when untreated runoff events can contribute up to ¼ of the river flow. (Author's abstract)
W85-02124

ORGANOCHLORINE RESIDUES IN BROOK TROUT FROM REMOTE LAKES IN THE NORTHEASTERN UNITED STATES

Maine Cooperative Fishery Research Unit, Orono. T. A. Haines. Water, Air and Soil Pollution, Vol. 20, No. 1, p. 47-54, July 1983. 1 Fig., 4 Tab, 18 Ref.

Descriptors: *Trout, *Pesticide residues, *Organochlorine pesticides, Acid precipitation, Water pollution sources, Regression analysis, Water chemistry, Maine, New Hampshire, Vermont, Air pollution, DDE, Polychlorinated biphenyls.

Organochlorine residues were analyzed in brook trout (Salvelinus fontinalis) collected from six undistributed lakes in Maine, New Hampshire and Vermont. The residues (whole body) were compared among age groups of fish and were correlated by regression analyses with water chemistry factors that might be affected by acid precipitation. There were significant differences in the organochlorine content of fish from different lakes but not among age groups of fish within each lake or among all lakes. There were no significant correlations between the water chemistry values measured and organochlorine content of the fish. Inasmuch as no organochlorine pesticides have been used within the lake watershed, the compounds must have reached these lakes by atmospheric transport. (Author's abstract)
W84-02126

OYSTER (CRASSOSTREA VIRGINICA) AS INDICATOR OF HEAVY METAL POLLUTION IN SOME LAGOONS OF THE GULF OF MEXICO

Rosas, I.; Baez, A.; Belmont, R. (Universidad Nacional Autonoma de Mexico, Mexico City). Water, Air, and Soil Pollution; 20: p. 127-135 (1983).

The littoral lagoons of the Gulf of Mexico have been investigated to determine the amount of heavy metal pollution. Some lagoons have been contaminated by liquid wastes mainly originating from sugar refining and petrochemical industries, as well as petroleum exploitation and refining. Since mollusks concentrate trace elements, determination of levels of Cd, Cr, Hg, and Pb in oysters (Crassostrea virginica) were measured in some of these lagoons. The results have shown that the concentrations of these metals in lagoon water were below the recommended levels to protect aquatic life, and it was found that oysters are able to concentrate metals, mainly Cd and Pb above the maximum permissible limits for edible consumption.

POPULATION BIOLOGY IN THE COURTROOM: THE HUDSON RIVER CONTROVERSY

Oak Ridge National Lab., TN. L. W. Barnthouse, J. Boreman, S. W. Christensen, C. P. Goodyear, and W. Van Winkle. BioScience, Vol. 34, No. 1, p. 14-19, January, 1984. 2 Fig., 1 Tab, 30 Ref.

Descriptors: *Decision making, *Model studies, *Hudson River, *Population dynamics, Fish populations, Bass, Environmental effects, Planning, Management, Direct impact accessment, Legislation.

The Hudson River controversy was a unique test of the ability of biologists to use their science to aid public decision makers in achieving an equitable solution to an important environmental problem. Some of the successes and failures of this effort are evaluated, based on years of experience of technical advisors and expert witnesses for the various federal agencies involved in the case. The major issue of the study was the use of mathematical models of fish populations as environmental assessment tools. The first attempt to quantify the impact of water withdrawals on the Hudson River striped bass population was based on a sim-

ple comparison of the average daily water withdrawal by the Cornwall facility to the average daily tidal flow of the Hudson. Various models were presented to make the analysis more correct, but the issue of entrainment impacts on striped bass had not been satisfactorily dealt with. This resulted in a remarkable proliferation of entrainment models as agency and utility scientists competed to produce the more realistic models. Each of the many settlement proposals discussed by the negotiators included a package of mitigating measures aimed at reducing the impact of entrainment on the fish. It seems certain that decisions about the need to mitigate the environmental impacts of man's activities will often have to be made on the basis of incomplete information, rather than being deferred indefinitely in the hope that scientists will come up with definitive solutions. (Baker-IVI)
W83-04283

REVIEW AND EVALUATION OF MICROCOSMS FOR ASSESSING EFFECTS OF STRESS IN MARINE ECOSYSTEMS

Adams, S. M.; Giddings, J. M. (Oak Ridge National Lab., TN). Environment International; 7: p. 409-418 (1982). Contract W-7405-ENG-26.

Representative estuarine-marine microcosms were reviewed and evaluated to provide recommendations and guidance for use in assessing effects of perturbations on coastal zone ecosystems. Properly designed marine microcosms can be effective assessment tools for evaluating the effects of stress on coastal ecosystems. Critical design considerations include scaling of important physical factors, such as turnover rate and circulation, inclusion of appropriate trophic groups, minimization of side growth, and maintenance of realistic nutrient regimes. Selection of communities or major components to be included in design of microcosms should be based on the experiment hypothesis, ecologically and economically important organisms, ability to interpret test results, difficulties involved in scaling, and sensitivity of the community to the stress being investigated. In selection of response parameters, emphasis should be placed on key ecological components, particle size distribution, and those variables that reflect aggregate responses at the population or community level.

STUDY OF POLLUTANT IMPACT ON FRESHWATER ECOSYSTEMS (N-8312639)

Andrushaitus, G. P.; Tsydmin, P. A. (AN Latvijskoj SSR, Riga). 1980. 6 p. NTIS MF A01 — WMO, Geneva, Switzerland.

The effects of pollutant concentrations on the physical and chemical characteristics of streams and the resulting eutrophication are reviewed. Runoff from a watershed and large amounts of discharged organic pollutants which cannot be assimilated and decomposed by biological self-purification processes result in the silting and overgrowing of streams, accumulation of pollutants in water and bottom sediments. The most important effect of pollution appears as a decrease of hydrobiont diversity and simplification of biocenotic structure, i.e., a low ratio of hydrobiont species number to specimen number in a simplified food web. Pollution results in an allogenic succession, the change of river biocenoses from oligosaprobic to polysaprobic ones, during which hydrobiont diversity and biomass decrease to such a degree that the stretch of the river becomes practically azoic. Biological self-purification is unable to completely restore the initial background state of the river and it stops under the conditions of saprobity which is one to two levels higher than the background.

SURFACE WATER CONTAMINATION BY INSECTICIDES : DATA FROM AQUATIC INSECT TESTS THAT PERTAIN TO WATER QUALITY CRITERIA

Ohio State Univ., Columbus, Dept. of Entomology. J. Collins, and R. Shank. Available from the National Technical Information Service, Springfield, VA 22161 as PB84-105378, Price codes: A05 in paper copy, A01 in microfiche. Water Resources Center Completion Report, September 1983. 75 p., 14 Fig., 7 Tab, 64 Ref. OWRT A-062-OHIO(1).

Descriptors: *Pesticide toxicity, *Aquatic insects, *Enzymes, Inhibitors, Acclimatization, Water quality, Water pollution, Metabolism, Respiration, Mayfly, Stonefly, Caddisfly, Midge, Winter, Summer, *Parathion, *Paraoxon, *Organophosphate insecticide, *Acetylcholinesterase, Mixed-function oxidase, Temperature effects.

Seven species of aquatic insects representing four orders were collected from natural waters in winter and summer seasons to investigate seasonal variation of toxicity of parathion and paraoxon, oxidative metabolism of these two chemicals and inhibition of acetylcholinesterase by paraoxon. Parathion was more toxic than paraoxon to both summer and winter forms of insects at 22C and 4C, respectively. The acetylcholinesterase of summer and winter forms exhibited the same inhibition characteristics with paraoxon. There was evidence for the existence of different seasonal isoenzymes of acetylcholinesterase in these species. Parathion is oxidatively metabolized (mixed-function oxidase) in aquatic insects but paraoxon was not. The toxicity of parathion was highest in those insects with the highest oxygen consumption. A midge exposed to parathion acquired high (> 85%) inhibition of acetylcholinesterase before toxic symptoms were observed and inhibited acetylcholinesterase required 4 to 5 days for regeneration. These data are related to water quality criteria for parathion and provide information on seasonal variation of susceptibility to organophosphate insecticides in aquatic insects.
W83-04139

USE OF ELECTROPHORESIS AND IMMUNOELECTROPHORESIS IN TAXONOMIC AND POLLUTION STUDIES

National Inst. of Oceanography, Panaji (India). M. R. Menezes and S. Z. Qasim. Proceedings of the Indian Academy of Science (Animal Science), Vol. 93, No. 3, p. 179-198, April, 1984. 6 Fig., 6 Tab, 50 Ref.

Descriptors: *Electrophoresis, *Tilapia, *Immunoelectrophoresis, *Water pollution effects, *Sublethal effects, Mercury, Immune system, Stress, Fish, Bioassay.

Stress conditions in fish may cause significant changes in the proteins of blood serum, hemoglobin, and eye lens proteins. Such changes might reflect an altered antibody synthesis, protein biosynthesis, cellular leakage, or perhaps other events resulting directly or indirectly from the stress. Long-term and short-term effects of inorganic mercury (mercuric chloride) on the electrophoresis patterns of a freshwater fish, Tilapia mossambica, were investigated under controlled conditions. Collateral studies included the uptake of mercury by the fish. The electrophoretic patterns of the serum and hemoglobin showed changes in response to low concentrations of mercury; these changes in number, mobility, and intensity of the fractions became evident in the serum proteins at a 0.05 ppm mercury exposure level. At this concentration, feeding behavior and swimming activity were altered and mercury concentrations in the blood increased. There was a general increase in the intensity of the low mobility serum protein fractions — a pattern similar to that found in the mammalian species under stress. Similar changes were also seen in the serum proteins of the fish exposed to relatively higher concentrations of mercury which were just below the lethal level. There is evidence that the low mobility proteins in the fish serum function as antibodies; this would indicate that the increased levels of these proteins in the exposed fish is due to a rapid and vigorous immune system response. Such indicators of stress responses would be useful for testing whether or not an effluent or a body of water containing a mixture of chemicals will collectively have a stressful effect of fish; the response would reflect the summation of effects, including synergistic effects, of pollutants. (Collier-IVI)
W85-02343

USE OF FREE-LIVING NEMATODES AS A BIOASSAY FOR ESTUARINE SEDIMENTS

City Coll., New York. Dept. of Biology. J. H. Tietjen and J. J. Lee. Marine Environmental Research, Vol. 11, No. 4, p. 233-251, 1984. 4 Fig., 5 Tab, 14 Ref. NOAA grant NA81RAD00003.

Descriptors: *Bioassay, *Nematodes, *Estuarine environment, *Sediment contamination, Hydrocarbons, Aromatic compounds, Heavy metals, Benthic fauna, Toxicity.

A bioassay technique using free-living nematodes has been developed to assess the environmental quality of estuarine sediments. Nematodies offer the advantages of (a) generally being the most abundant metazoan in sediments; (b) having short life histories and no pelagic larvae; and (c) being relatively easy to maintain in laboratory culture. Small individual body size and rapid generation time (two weeks) render nematodes especially useful in evaluating effects of potential toxicants on populations, rather than on single individuals. The bioassay technique was developed using two species, Chromadorina germanica and Diplolaimella punicea, and sediments from the Hudson-Raritan estuarine area. The life histories and feeding habits of both species are known. Test sediments were taken from eight stations that represent a gradient from lightly to heavily impacted. Concentrations of potential toxicants measured in these sediments included polychlorinated hydrocarbons, polynuclear aromatic hydrocarbons, and heavy metals. Control sediments, taken from 100 km distant, were almost total toxicant-free. Nematodes were incubated in the dark at 25 degrees C for two weeks at 1:1 and 1:10 concentrations (volume/volume) of sediments prepared with sterile sea water. Food consisted of bacteria from nematode stock cultures. Intrinsic rate of natural increase (r) of the nematodes was used as the indicator of sediment quality; r has units (daily increase in number of generations), is easily computed, and can be treated statistically. Both species grew better in control and other sediments containing low concentrations of PCBs PAHs, and heavy metals. In sediments having PCB and PAH concentrations (ppb) of more than 270 and 8700, respectively, population growth of both species tended to be less than half that found at lower concentrations. Significant inverse correlations between r and toxicant concentration occurred at 1:1 sediment-water concentrations. At 1:10 concentrations the correlations remained negative, but not at the 0:05 level of significance. Use of the nematodes Chromadorina germanica and Diplolaimella punicea offers a quick, easy and statistically testable means of assessing the quality of marine sediments on populations, rather than single individuals, of marine benthic invertebrates. (Author's abstract)
W85-01354

USE OF NONSPECIFIC RESPONSE OF AQUATIC POPULATIONS TO THE IMPACT OF POLLUTANTS AS A MONITORING SYSTEM (N-83122645)

Trunov, N. M.; Korolenko, P. T.; Brazhnikova, L. V. (Gidrometerologicheskii Nauchno-Issledovatel'skii Tsentr SSSR, Moscow (USSR)). 1980. 3 p. NTIS MF A01 — SMO, Geneva, Switzerland.

Nonspecific intracellular changes include decreases in dispersity of cytoplasm and nucleus colloids, increase of cytoplasm viscosity, increase of cytoplasm viscosity, increase of cytoplasm and nucleus affinity to a dye change in cellular permeability increase of cytoplasm acidity and change of capability for granule formation. The use of dyes for objective quantitative evaluation of nonspecific effects is proposed, using microfluorometric methods. A dye such as acridin orange fluorochrom concentrates within lysosomes and is characterized by bright red luminescence, while acridin orange distributed diffusely with the cell makes structures of the nuclei and cytoplasm luminesce green. Any influence causing stimulation or depression of lysosome cell leads to the change of the ratio between two major components of the cell luminescence spectrum red and green. This ratio can be easily measured by means of a simple fluorometric unit for the luminescent microscope with a photomultiplier and light filters.

USE OF THE MUSSEL MYTILUS, EDULIS-PLANULATUS (LAMARCK) IN MONITORING HEAVY METAL LEVELS IN SEAWATER

Tasmania Univ., Hobart (Australia). Dept. of Zoology. D. A. Ritz, R. Swain, and N. B. Elliott. Australian Journal of Marine and Freshwater Research, Vol. 33, No. 3, p. 491-506, 1982. 9 Fig., 3 Tab, 25 Ref.

Descriptors: *Heavy metals, *Seawater, *Monitoring, *Bioassays, *Mytilus, Water pollution effects, Cadmium, Copper, Lead, Zinc, Accumulation, Animal tissues, Mussels, Absorption, Bioindicators, *Australia, Tasmania, Pollutant identification.

The accumulation of cadmium (Cd), copper (Cu), lead (Pb) and zinc (Zn) in tissues of the mussel, Mytilus edulis planulatus, was examined in seawater spiked with different metal concentrations. A linear relationship was found for all the metals tested and for some metals even after exposure to the metal for up to 86 days. The relationship between a metal's concentration in seawater and its rate of accumulation in M. e. planulatus over a 40-day period was determined. Field test results showed that the rate of accumulation could be used as a sensitive method for estimating metal concentrations in seawater with less trouble than techniques involving direct analysis. A monitoring program is proposed in which M. e. planulatus may be used to quantify concentrations of heavy metals in seawater. Some biological and physicochemical parameters which may affect the accumulation of heavy metals in M. e. planulatus and limit the usefulness of this mussel as a bioassay organism in monitoring programs are considered. (Geiger-FRC)
W83-04053

WATER POLLUTION: A VIEW FROM ECOLOGY

McGill Univ., Montreal (Quebec). Inst. of Oceanography. G. Sabatini and B. M. Marcotte. Marine Pollution Bulletin, Vol. 14, No. 7, p. 254-256, 1983. 1 Tab, 15 Ref.

Descriptors: *Bioassay, *Water pollution effects, Industrial wastes, Environmental effects, Pollutant identification, Trout, Diatoms, Marine bacteria.

The results of various methods typically used by governments to assess the environmental impact of potential pollutants do not give comparable results. it is argued that the cause is not the assessment techniques themselves, but rather the paradigm of ecology from which they spring. Three bioassays are examined: LC-50, EC-50, and CI-50. The potentially toxic pollutant tested with the three bioassays was a heavy metal effluent from a plating industry containing 1.5 ppm Cr and 26.3 ppm Ni. Bioassay species used included the trout Salmo gairdnerii, the marine diatom Thalassiosira pseudonana and the marine bacterium Photobacterium phosphoreum. Three entirely different results were obtained with the three different techniques used. (Baker-IVI)
W84-03537

A MONITORING/MODELING STRATEGY FOR 208 IMPLEMENTATION

Purdue Univ., Lafayette, IN. Dept. of Agricultural Engineering. D. B. Beasley, L. F. Huggins, and E. J. Monke.

Transactions of the ASAE, Vol. 25, No. 3, p. 654-660, 665, May/June, 1982. 3 Fig., 1 Tab, 4 Ref.

Descriptors: *Nonpoint pollution sources, *Model studies, Simulation, Pollution load, Water quality, Water management, Monitoring, ANSWERS, Watersheds, Sediment yield, Sediment transport, Water resources development.

The manner in which a well-adapted simulation model cna be used as both a planning and evaluation tool for agricultural nonpoint source pollution has been demonstrated with two case studies. Such results are a direct consequence of using a model which is constructed from established cause-effect relationships between governing process and is designed to analyze impacts of the type of control measures selected. A simulation model that analyzes cause-effect relationships in a site specific manner is the only methodology currently available for rational planning or evaluation of storm induced nonpoint source pollution control. The Finely Creek case study demonstrated how ANSWERS (Areal Nonpoint Source Watershed Environmental Response) simulations could be used in a planning role to quantify Best Management Practices (BMP) impacts and rank site specific BMP's. Maximum benefits from simulation accrue when it is applied at the earliest project planning stages. This example also illustrates how a ranking of alternative control strategies depends on the user in the selection of a baseline condition. The Black Creek Study demonstrated that it is impossible to quantify benefits from individual BMP's by monitoring the outlet of a natural, diverse watershed. The annual reduction in sediment yield from only 10% from the eastern third of the watershed to 30% from the western, most densely treated, third. Further, simulation studies indicated that a reduction of 50% was feasible if the installed structural BMP's had been augmented with chisel plowing in selected critical area. (Baker-FRC)
W83-00890

A QUESTION OF SAMPLING

Welsh Water Authority, Powys (Wales). Directorate of Scientific Services. D. G. Salker.
Effluent and Water Treatment Journal, Vol. 22, No. 5, p. 184-185, 187-189, 191, may, 1982. 3 Fig., 10 Ref.

Descriptors: *Sampling, *Measuring instruments, *Design criteria, Sample preservation, Sample preparation, Water sampling, Biological samples, Water analysis, Chemical analysis, Pollutant identification.

A brief introduction to the concepts, applications and limitation of sampling as a means of water quality monitoring is presented. The nature of sampling is briefly discussed in addition to the practical aspects that are of assistance in answering questions such as what type of sample should be taken, where should sampling be done, when should samples be taken, how many are needed, and why sample at all. Sampling is an activity that may be used to abstract water quality information with great economy of effect, provided care is taken in all aspects of the planning of a scheme. Good planning for sampling to be effective requires the following criteria and expertise to be met: a clear idea of the objective of the program, sound technical knowledge, and good judgement aided by statistical techniques where needed. In most cases discrete, intermittent sampling is used as opposed to continuous sampling for economic and other practical considerations. In choosing a position from which to sample, care must be taken to provide samples that are valid. Samples should be taken so as to reveal any differences in diurnal times, variations between days, weeks, months or seasons. There are two major types of samples: The single discrete sample and the composite sample. The number of samples needed to indicate various findings is discussed. (Baker-FRC)
W83-03595

ALTERNATIVE METHODS OF ESTIMATING POLLUTANT LOADS IN FLOWING WATER

Wisconsin Dept. of Natural Resources, Madison, K. Baun.
Technical Bulletin No. 133, 1982. 11 p., 2 Fig., 9 Tab, 12 Ref.

Descriptors: *Water sampling, *Pollution load, *Stream pollution, *Monitoring, *Water quality standards, Streamflow, Water quality criteria, Water quality control, Urban runoff, Statistics, Statistical analysis, Mathematical studies, Runoff.

A comparison is provided of three principal methods of estimating pollutant loads in flowing water: integration; composite; and stratified random sampling, enhanced with ratio estimation. The latter is a relatively new approach to estimating pollutant loads. It enables an estimate of confidence limits to be placed upon the loading estimates, and also enables unsampled flows to be included in the loading estimates with some knowledge of the uncertainties involved. In addition, stratified random sampling can probably give accurate loading estimates with considerably fewer samples than would normally be required with integration, and will give better estimates than other simple statistical calculations. Two disadvantages of stratified random sampling are that it becomes proportionately more expensive if the number of samples is larger than would be required for composite analyses; and larger error terms than desired can result if the appropriate number of samples is not selected. Likewise, where integration works well, it does so

only because the flows are extensively sampled and, hence, is very expensive. It does not enable an error term to be placed on the loading estimates, and it has limited applicability at new stations. Composite sampling may be very accurate and inexpensive when events are well sampled. further, it allows for excellent inter-event analysis. The major drawback is a lack of an error term. (Garrison-Omniplan)
W83-03557

APPARATUS FOR SAMPLING OF STREAMS FOR CHEMICAL QUALITY AND SEDIMENT

Jonkersoek Forestry Research Station, Stellenbosch (South Africa). Dept. of Environmental Affairs. D. B. Van Wyk.
Water South Africa, Vol. 9, No. 3, p. 88-92, July, 1983. 4 Fig., 2 Tab, 7 Ref.

Descriptors: *Sampling, *Streams, *Storm runoff, Monitoring, Measuring instruments, Costs, Automation, Bed load.

An apparatus was designed to automatically collect samples from streams during spates. The system enables stage samples to be taken during both the rise and recession of spates and functions on natural hydraulic pressures created by changes in stream level. A system for the measurement of bed load deposits that has been in use since 1978, is also described. These techniques have proved effective and cost is low when compared with other equipment marketed for similar purposes. The sampling record shows a success rate of 95% over two rainy seasons in the Western Cape (South Africa). The success/failure rate is reported for 5 catchments where the apparatus was well maintained. Blockages caused by debris, and air leaks are the only factors that cause sampling failure. (Baker-IVI)
W84-02308

ARTIFACTS AND LOSSES IN THE SAMPLING OF CHLORINATED WATERS BY XAD ADSORPTION

American Univ., Washington, D.C. Dept. of Chemistry. A. M. Chech.
Available from the National Technical Information Service, Springfield, VA 22161 as PB83-208843, Price codes: A04 in paper copy, A01 in microfiche. Water Resources Research Center, University of the District of Columbia, Report No. 45, April 1983. 58 p., 14 Fig., 4 Tab, 9 Ref. OWRT A-017-DC(1), 14-34-0001-2109.

Descriptors: *Water sampling artifacts, *Chlorination, *XAD resins, *Mutagens, *Ames assay, High performance liquid chromatography, Electrophiles, *Pollutant identification.

Chlorination of natural waters generates mutagens the most likely are electrophiles. These electrophiles are often recovered for testing and analysis by adsorption to XAD resins. it was found that the production of artifacts stemming from the action of free chlorine on XAD-4 resin could be suppressed at least ten fold by converting the free chlorine to chloramine. Kinetic studies indicate that free chlorine is consumed at least ten times as rapidly by XAD-4 as in chloramine. Sampling losses during XAD recovery of electrophiles and mutagens were also examined. Mutagenic activity bound to resins generally decreased over a period of several days but some increases were seen. Electrophiles labeled by 4-nitrothiophenol generally decreased concurrently, but sometimes new species were seen. Organics concentrates in ethanol did not appear to lose mutagenic activity as rapidly as concentrations in DMSO. Simultaneous electrophile assays, however, indicated up to 50% loss of some electrophiles present in ethanol concentrates.
W83-03104

AUTOMATIC DILUTION GAGING OF RAPIDLY VARYING FLOW

Geological Survey, Madison, WI. Water Resources Div. M. D. Duerk.
Available from the OFSS, USGS, Box 26425, Fed. Ctr., Denver, CO 80225. USGS Water-Resources Investigations Report 83-4088, October 1983. 17 p., 12 Fig., 3 Tab, 7 Ref.

Descriptors: *Discharge measurements, Discharge hydrographs, Rapid flow, *Varied flow, *Fluorometry, Fluorescence, Dye, Automated, Storm sewer, Urban hydrology, *Dye dilution gaging, Constant-rate injection, *Automated gaging.

Obtaining discharge ratings at urban gaging stations is often difficult. Results of using an automated constant-rate dye-dilution technique to measure discharge at two sites in Madison, Wisconsin, are presented. The sites selected have well-defined stage-discharge ratings, developed during previous hydrologic studies. One site is a 60-inch-diameter concrete storm sewer and the other a concrete lined open trapzoidal channel. Equipment selected to automate the method include a portable automatic water sampler, four-channel event recorder; and for dye injection, a peristaltic pump. An electrical switching circuit was designed to coordinate the operation of the water sampler, injection pump, and four-channel recorder. During the data-collection period of 1 year, a total of 20 storms was monitored. The analyses showed that the discharges measured by dye-dilution techniques ranged from + or − 5 to + or − 10 percent of the discharges determined from ratings established by current-meter measurements. Larger differences were noted at the start of an on the rising limb of four hydrographs. Of the 20 storms monitored, 17 produced acceptable results. Peak discharges by the dilution method at the open-channel site ranged from 0 to 12 percent departures from the existing rating, whereas the peak discharge by the dilution method at the storm-sewer site ranged from 0 to 5 percent departures from the existing rating. (UGGS)
W85-00852

BINOMIAL ACCEPTANCE SAMPLING PLANS FOR EVALUATING OIL-WATER SEPARATION PERFORMANCE. TECHNICAL REPORT (AD-A-135621/1)

Burns, K. C. (Desmatics, Inc., State College, PA (USA)). Nov. 1983. 20 p. (TR-106-13). NTIS, PC A02/MF A01.

There are several oil-water separation systems currently being developed for possible future use aboard Navy ships. In order to be accepted, these systems must meet certain specified requirements: In Port — 20 ppm of oil or less in effluent water at least 95% of the time; and At Sea — 100 ppm of oil or less in effluent water at least 99% of the time. In order to determine whether a system meets the threshold requirements given above, a binomial acceptance sampling plan is often used. In this type of plan, a specified number of effluent samples are collected and analyzed. Each sample is then classified as either a success (oil content does not exceed threshold) or a failure (oil content exceeds threshold). If the number of failures is not greater than some prespecified number, c, the system is accepted. If the number of failures exceeds c the system is rejected.

CHUTE ENTRANCES FOR HS, H, AND HL FLUMES

Agricultural Research Service, Stillwater, OK. Crop Production and Water Conservation Lab. W. R. Gwinn.
Journal of Hydraulic Engineering, Vol. 110, No. 5, p. 587-603, May, 1984. 13 Fig., 4 Tab, 6 Ref., 2 Append.

Descriptors: *Flumes, *Chute entrances, *Flow measurement, Open channel flow, Runoff, Sediments, Hydraulic jump, Turbulence, Mixing.

The HS, H, and HL flumes have a proven performance for measuring runoff from watersheds and flows in open channels. In order to reduce problems with ponding and sediment deposition, new Chute entrances were designed for the flumes. The flumes were calibrated with the new Chute entrances in place for both free and submerges outfall conditions. Sediment was fed into the flow to evaluate Chute entrance and flume performance when conveying sediment-laden flows. In the HL flume with a flat floor approach the discharge ranged from 6.5% below published table values for low flows to almost no difference at the maximum head. Generalized discharge equations for HS, H, and HL flames with Chute entrances are given. A direct solution for the effect of submergence on HL flumes is presented in equation form. The hydraulic jump which forms on the sloping floor of the Chute for all flows causes turbulence in the jump which helps keep sediment in suspension and provides mixing for water quality measurements. The depth of ponding over the approach is reduced to half of what it would be if no Chute were provided. Sand in the flow will deposit at the lower end of the Chute and in the flume. Discharge corrections are provided for sediment concentrations less than 11,000 mg/L (1.1%) in the HS flume with Chute entrance and collector trough. (Moore-IVI)
W84-05146

CONSOLIDATION OF A STREAM QUALITY MONITORING NETWORK

Washington Univ., Seattle. Dept. of Civil Engineering. D. P. Lettenmaier, D. E. Anderson, and R. N. Brenner.
Water Resources Bulletin, Vol. 20, Vol. 4, p. 473-481, August, 1984. 5 Fig., 3 Tab, 13 Ref.

Descriptors: *Water quality, *Monitoring networks, *Streams, *Rivers, *Seattle, *Washington, Monitoring, Network design, Cost analysis.

A method was devised for the consolidation of a stream quality monitoring network, based on the stream network characteristics and a set of station attributes. The approach utilizes a heirarchical structure; stations are allocation to what are termed primary basins on the basis of a weighted attribute score, and specific station locations within each primary basin are specified using a criterion based on stream order numbers. Application of the method to the Municipality of Metropolitan Seattle's routine streams and rivers monitoring network aided in reduction of the network from 81 baseline stations to 47 stations, at a savings of approximately $33,000/yr, exclusive of equipment depreciation and indirect costs. The dynamic program results were used to specify the initial network reduction, which was modified slightly by inclusion of additional, nonquantifiable information such as field personnel judgement, political consideration, and the potential for inclusion of monitoring stations maintained by other agencies. (Moore-IVI)
W85-02973

CONTAMINATION OF SUCCESSIVE SAMPLES IN PORTABLE PUMPING SYSTEMS

Pacific Southwest Forest and Range Experiment Station, Arcata, CAR. B. Thomas and R. E. Eads. Water Resources Research, Vol. 19, No. 2, p. 436-440, April 1983. 4 Fig., 1 Tab, 5 Ref.

Descriptors: *Water sampling, *Suspended sediments, Monitoring, Water quality, Particle size, Sample contamination, Pumping samplers.

Automatic discrete sample pumping systems used to monitor water quality should deliver to storage all materials pumped in a given cycle. If they do not, successive samples will be contaminated, a severe problem with highly variable suspended sediment concentrations in small streams. The cross-contamination characteristics of two small commonly used portable pumping samplers are compared to each other and to reference measurements under conditions of sudden and severe changes in suspended sediment concentrations. The pressure-vacuum sampler showed greater cross contamination, especially when changing from high to zero concentrations, than the peristaltic sampler. Both samplers, however, cross-contaminated to some degree. The contamination was primarily due to the sand size particles rather than to the finer sizes. (Author's abstract)
W84-01363

EFFECTS OF VISITATION FREQUENCY AND INSTRUMENT RELIABILITY ON THE ACCURACY OF ESTIMATION OF RIVER DISCHARGES

Iowa Inst. of Hydraulic Research, Iowa City. P. K. Kitanidis, O. G. Lara, and R. W. Lane
Hydrological Sciences Journal, Vol. 29, No. 3, p. 255-269, 1984. 2 Fig., 4 Tab, 7 Ref.

Descriptors: *Measuring instruments, *Streamflow, *Model studies, Probabilistic models, Flow discharge, Simulation.

The extent to which improved instrumentation and longer visitation periods result in improved accuracy of estimation of streamflow quantities is examined. A relatively simple probabilistic model of the process of gauging-station failures is developed, calibrated, and validated. This model can be used to derive the distributions of the number of failures and the length of missing records and, through simulation, to calculate the accuracy of daily or monthly streamflow values. The paper focuses on the description of the probabilistic model, on the derivation of the distribution of the number of failures and the length of missing record, and on the estimation of parameters from data. For illustration, the performance characteristics of 168 gauging stations are analyzed. (Baker-IVI)
W85-02825

EVALUATION OF A SAMPLER FOR LIQUID EFFLUENTS

Imperial Chemical Industries Ltd., Brixham (England). Brixham Lab. F. J. Whitby, D. R. Cottrell, D. C.-W. Lau, and E. Bishop. Water Research, Vol. 17, No. 11, p. 1491-1498, 1983. 3 Fig., 7 Tab, 15 Ref.

Descriptors: *Effluents, *Samplers, Automation, Suspended solids, Wastewater, Oil, Organic compounds.

A design of automatic sampler for liquid effluent streams is described, which is based on the use of a rapidly circulating pumped stream of the liquid effluent. This stream passes through an interceptor vessel from which sub-samples may be taken isokinetically to provide a variety of samples types (e.g. snap, composite, flow-related). This interceptor may be conveniently located an may also be used to hold monitoring probes (pH, ion selective electrodes) which will provide continuous information on the composition of the effluent stream. This sampler system has been evaluated using simulated liquid effluents, chosen to represent cases in which it is difficult to acquire a truly representative sample. The cases chose were: (a) water containing up to 10,000 mg/l of finely divided inorganic solid; (b) water containing 2000 mg/l of sewage solids; (c) water containing dissolved, volatile organic solutes; (d) water containing dispersed oil. In all cases it proved practical to obtain samples which were representative in composition of the liquid being tested; comparison in all cases was with snap samples taken simultaneously from appropriate points in the loop system. The sampler appears to be generally suitable for use with most types of liquid effluents. The several components of the sampler should be constructed of materials which are inert to the effluent. (Author's abstract)
W84-02699

EVALUATION OF THE EFFICIENCY OF STREAMFLOW DATA COLLECTION STRATEGIES FOR ALLUVIAL RIVERS

Iowa Univ., Iowa City, IA, Inst. of Hydraulic Research. P. K. Kitanidis, O. G. Lara, and R. W. Lane. Journal of Hydrology, Vol. 72, No. 1/2, p. 85-103, April, 1984, 2 Fig., 1 Tab, 10 Ref.

Descriptors: *Missouri River, *Alluvial rivers, *Data acquisition, *Stream discharge, Stage-discharge relations, Sampling, Costs.

In alluvial streams, stage-discharge relationships change continually and, sometimes, quite markedly; such changes may be caused by major floods, seasonal variation, or long-term secular trends associated with changes in the river channel. Consequently, reliable estimates of discharge using rating curves are not possible unless frequent direct measurements of discharge are made. Such measurements involved appreciable costs, and it is important to evaluate their contribution in increasing the accuracy of estimation of quantities of interest such as mean daily, monthly or annual flow. A methodolgoy for the evaluation of the efficiency of data-collection strategies for alluvial rivers was developed and applied to 10 stations on the Missouri River, throughout the length of a navigation channel between river miles 98 (Herman, Missouri) and 732 (Sioux City, Iowa). A flexible and expedient model describing the variability of discharges and shifts in the stage-discharge relationship was developed. The calibrated and validated model was then employed in simulations to evaluate the effect of sampling strategies (such as frequency and accuracy of discharge measurements) on the accuracy of estimated mean daily, monthly and annual flow. Curves relating the cost of sampling to the achieved accuracy can be generated, and the optimization of sampling strategies given accuracy or budget objectives or constraints can be achieved. (Collier-IVI)
W85-01170

EVALUATION OF WATER QUALITY SAMPLING LOCATIONS ON THE YUKON RIVER

Inland Waters Directorate, Vancouver (British Columbia). Pacific and Yukon Region. P. H. Whitfield.
Water Resources Bulletin, Vol. 19, No. 1, p. 115-121, February, 1983. 4 Fig., 5 Tab, 14 Ref.

Descriptors: *Water quality, *Evaluation, *Sampling, Samples, Yukon River, *Alaska, Yukon Territory, Monitoring.

An approach was developed and used to evaluate sampling locations on the Yukon River between Dawson in the Yukon Territory and Eagle, Alaska. Spatial heterogeneities and temporal variations in a number of water quality variables at four locations on the Yukon River were examined to determine an optimum sampling location and to estimate a necessary frequency and density of sampling for long term monitoring. At three of the four study sties it was difficult to obtain representative samples due to the presence of extensive lateral heterogeneities. These heterogeneities occur because of a lack of mixing between the Yukon River and the major tributaries upstream from

Dawson. Only one of the sampling locations was spatially homogeneous enough to provide representative samples. Concentration variations over the annual cycle are very large, often as much as two orders of magnitude. Estimates are made of the frequency and density with which samples must be collected to be able to detect a 10% difference between annual mean concentrations. The estimated frequencies are so large that such an undertaking would be impractical. More importantly, the assumptions of this analysis are invalid, and time series analysis of of fixed frequency samples is proposed as an alternative that is statistically rigorous and requires fewer samples. (Baker-FRC)
W84-00097

FIELD INSTRUMENTATION FOR MONITORING WATER, QUALITY EFFECTS OF STORM WATER RUNOFF FROM HIGHWAYS

T. V. Dupuis and B. N. Lord
Transportation Research Record No. 896, p. 55-60, 1983. 8 Fig., 7 Ref.

Descriptors: *Highway effects, *Storm runoff, *Monitoring, Water quality, Storm water, Hydrocarbons, Metals, Water pollution sources.

Storm-water runoff from operating highways can carry considerable quantities of pollutants, especially petroleum hydrocarbons and solids and metals, into the nation's receiving waters. The Federal Highway Administration, charged with the responsibility of protecting the environment from pollution from highway sources, has approached the problem in a multiphase research effort. The objective of the first phase was to identify and quantify the constituents of highway runoff. The next phase sought to identify sources and migration paths of these pollutants from the highways to receiving waters. The third phase, currently in progress, is analyzing actual impacts of highway runoff on receiving water. A wide variety of instrumentation has been used in the field monitoring portions of the investigation. Physical, chemical, and biological characterizations have been made. A general description of the types of equipment used in all three phases of the Research program is presented. Special instrumentation and tests for source and migration studies include saltation catchers, zero-tension lysimeters, and sweeping and flushing. Saltation catchers were designed to capture saltating (moving by a series of jumps) particles from roadway surfaces. Zero-tension lysimeters measure groundwater percolation out of the major rooting zone. Sweeping and flushing studies were performed to quantify the accumulation and distribution of pollutants on the highway surface. (Moore-IVI)
W84-02228

INEXPENSIVE WEIR AND PROPORTIONAL SAMPLER FOR MINIATURE WATERSHED ECOSYSTEMS

Environmental Protection Agency, Washington, D.C. Office of Pesticides and Toxic Substances. J. V. Nabholz, D. A. Crossley, Jr., and G. R. Best.
Water Resources Bulletin, Vol. 20, No. 4, p. 619-625, August, 1984. 3 Fig., 2 Tab, 19 Ref., DOE contract DE-AS09-76EV00641

Descriptors: *Weirs, *Samplers, *Small watersheds, Soil-island ecosystems, Water sampling, Rainfall runoff.

Small ecosystems, called soil-island communities, occur in depressions on granitic outcrops. These ecosystems are typically irregularly circular, and only several meters in width. A weir system with a proportional sampler for use on such miniature watershed ecosystems is described. Eight weir collection systems were evaluated for their ability to measure and sample inputs and outputs of soil island ecosystems. The proportional water samples collected by the weir collection systems were adequate for elemental analysis and provided sufficient data for calculating elemental budgets. Although some of the proportional samples were less than the weir systems were designed to collect, a composite, proportional sample was obtained through-out an entire precipitation event. The greatest danger to sample accuracy is exceeding the capacity of the system. The weir systems were not able to account to 25 to 50% of the variation in total water passing over the cutoff wall. Optimal performance of a proportional sampler occurs when volume of water flow is near maximum rather than near minimum. (Moore-IVI)
W85-02990

LABORATORY EVALUATION OF GROUND WATER SAMPLING MECHANISMS

Illinois State Water Survey Div., Champaign, IL, Aquatic Chemistry Section. M. J. Barcelona, J. A. Helfrich, E. E. Garske, and J. P. Gibb.
Ground Water Monitoring Review, Vol. 4, No. 2, p. 32-41, Spring, 1984. 4 Fig., 10 Tab, 11 Ref.

Descriptors: *Groundwater, *Sampling, Reviews, Pumps, Monitoring, Chemical compounds, Water analysis, Pollutant identification.

The task of obtaining representative samples of ground water in both research and compliance monitoring programs must be carefully approached. Most pumping mechanisms may be expected to perform satisfactorily for well purging and the measurement of solution parameters. Sampling for gas sensitive and volatile chemical constituents can be significantly biased by degassing and loss of volatiles during sample collection. Significant bias and poor precision may be expected in shallow ground water sampling with gas displacement, positive displacement mechanical, and suction mechanisms, unless extraordinary care is taken in sample retrieval, transfer and collection. Bladder (no gas contact) pumps are superior for most applications. The performance of grab samplers, particularly bailers, is heavily dependent on both the expertise of sampling personnel and field conditions. The ideal controlled conditions under which these performance data were collected represent an optimum situation for the observance of minimal sampl-

ing error. Field conditions and solution composition are complicating factors that must be evaluated on a case by case basis. (Baker-IVI)
W85-00364

LIMIT OF DETECTION AND LIMIT OF DETERMINATION AS CRITICAL PERFORMANCE CHARACTERISTICS OF COMPLETE MEASURING METHODS IN THE FIELD OF ENVIRONMENT ANALYSIS

Bos, U.; Junker, A. Freshlus Zeitschrift fuer Analytische Chemie; 316: No. 2, p. 135-141 (Sep 1983). (In German).

Recently the technique of analytical devices or measuring procedures has been considerably improved regarding the detection of smallest amounts as e.g., constituents of products, or pollutants of water, air, or soil. Following these improvements the discussion about these smallest amounts, assumed to be acceptable for hygienic reasons, should also include the analytical quality of such measurements. This leads to basic considerations about the performance of measuring methods to be applied. In this paper some of the essential performance characteristics especially the terms "limit of detection" and "limit of determination" are investigated. The theoretical concept is derived from statistical reflections with respect to the calibration process of the so called "completed measuring method." All definitions are given as well as the relations of these terms to one another resulting from the calibration function and its confidence limits. It is worthwhile to note that the limit of detection is defined on the scale of instrument readings, whereas the limit of determination is defined exclusively on the scale of measured values which is the essential scale regarding the task. The limit of determination can be understood to be the image of the limit of detection using the calibration function as a mirror. These definitions include an extensive procedure to determine quantitatively the performance characteristics. The influence of various sensitivities of different procedural steps used in a complete measuring method is examined with respect to the limit of determination.

MEASUREMENT AND COMPUTATION OF STREAMFLOW: VOLUME 1. MEASUREMENT OF STAGE AND DISCHARGE

Geological Survey, Menlo Park, Ca. Water Resources Div. S. E. Rantz.
Available form Supt. of Documents, GPO, Washington, DC 20402, Price, $13,00 per set. USGS Water Supply Paper 2175, 1982. 284 p., 138 Fig., 15 Tab, 69 Ref.

Descriptors: *Discharge (Water), *Discharge measurement, *Stage discharge relations, *Water levels, Backwater, Current meters, ice cover, Open-channel flow, Peak discharge, Pipe flow, Streamgages, Tidal streams, Water level recorders, *Streamgage controls, Acoustic-velocity meters, Deflections meters, Dishcarge-rating shifts, Sand channels, Slope.

This stream-gaging manual, in two volumes, describes the equipment and technical work involved in obtaining systematic records of streamflow. The subject is treated in accordance with six major topics. Volume 1, titled "Fieldwork," covers (1) selection of gaging-station sites, (2) measurement of stage, and (3) measurement of discharge. In order to make the text as broadly as possible, discussions of instrumentation and measurement are aimed at the technician, and discussions of instrumentation of computational procedure are aimed at the junior engineer who has background in basic hydraulics. The section on the design of gaging-station networks is written for the experienced hydrologist who plans such networks. (USGS)
W84-01048

METHOD FOR RELATING SUSPENDED-CHEMICAL CONCENTRATIONS TO SUSPENDED-SEDIMENT PARTICLE-SIZE CLASSES IN STORM-WATER RUNOFF

Geological Survey, Portland, OR. Water Resources Div. J. F. Rinella and S. W. McKenzie.
USGS Water Resources Investigations 82-39, 1982. 43 p., 9 Fig., 7 Tab, 6 Ref.

Descriptors: *Water quality, *Sediments, *Chemical analysis, *Storm runoff, *Sediment transport, Settling basins, Particle size, Suspended chemicals, Chemical transport, Chemical partitioning, Sediment fall diameters.

A method has been developed to relate suspended-chemical concentrations (associated with suspended sediments) in storm-water runoff to suspended-sediment particle-size classes. These classes are based on settling velocities in quiescent native water. this method requires processing 20 liters of water having a suspended-sediment concentration greater than 500 milligrams per liter. However, samples with suspended-sediment concentrations as low as 250 milligrams per liter may be analyzed, if sample volumes are increased to 50 liters. The time required for one person to separate suspended sediments into particle-size classes ranges from 6 to 14 hours. This report outlines procedures for processing metal, nutrient, and organic samples. (USGS)
W85-00614

QUALITY ASSURANCE PRACTICES FOR THE CHEMICAL AND PHYSICAL ANALYSES OF WATER AND FLUVIAL SEDIMENTS

Geological Survey, Lakewood, CO. L. C. Friedman and D. W. Erdmann.
Available from the Eastern Distribution Br. USGS, 604 S. Pickett St. Alexandria, VA 22304. USGS Techniques of Water-Resources Investigations, Book 5, Laboratory Analysis, Chapter A6, 1982, 181 p., 35 Fig., 40 Tab, 72 Ref.

Descriptors: *Quality control, Statistical methods, Evaluation, *Analytical techniques, *Instrumentation, Test procedures, Documentation, Data collection, Measurement, *Water analysis, Reliability, Water quality control, Data storage and retrieval, Chemical analysis, Biological properties, Materials testing, Charts, Sampling.

This manual contains practices used by the U.S. Geological Survey to assure that quality of analytical data for water, fluvial sediment, and aquatic organisms. These practices are directed primarily toward personnel making water-quality measurement. Some detail specific quality control techniques, others document quality assurance procedures being used by the Central Laboratories System of the U.S. Geological Survey and still others describe various statistical techniques and give examples of their use in evaluating and assuring the quality of analytical data. The practices are arranged into eight sections: Analytical Methods Development Procedures; Standard Quantiative Analysis Techniques; Instrumental Techniques; Reference Material; Laboratory Quality Control; Quality Assurance Monitoring; Documentation, Summary, and Evaluation of Data; and Materials Evaluation. Each section is preceded by a brief description of the material covered. Similarly within each section, each practice is preceded by a description of its application or scope. (USGS)
W84-00812

RBC BROAD-CRESTED WEIRS FOR CIRCULAR SEWERS AND PIPES

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. A. J. Clemmens, M. G. Bos, and J. A. Replogle. Journal of Hydrology, Vol. 68, p. 349-368, 1984. 8 Fig., 2 Tab, 23 Ref.

Descriptors: *Weirs, Pipes, Sewer systems, Flow, Design criteria.

Existing experience with and theory of long-throated flumes has led to the adaptation of the RBC Broad-crested weir to flow in circular pipes flowing partly full. The ideal flow equations were solved and the resulting stage-discharge relationship is listed. A mathematical model of flow over broad-crested weirs was used to determine the stage-discharge relationship for actual flow. The results were fit to an empirical equation in nondimensional form for a wide range of sill heights and pipe sizes. Maximum capacity and head loss requirements for any given weir size are given. Maximum calibration errors result from several sources including: basic calibration, effects of friction not accounted for by Froude modeling, effects of empirical curve fit, and errors in zero setting and depth detection. An example is given which shows how to design these weirs to minimize the effects of the weir on flow conditions in the channel. In many situations, these weirs are simple and inexpensive to construct and should be easily adapted to current measurement needs in circular open channels. (Baker-IVI)
W84-03350

SAMPLING STRATEGY FOR RIVER POLLUTANT TRANSPORT

Corps of Engineers, Buffalo, NY Buffalo District. S.M. Yaksich and F.H. Verhoff. Journal of Environmental Engineering, Vol. 109, No. 1, p. 219-231, February, 1983. 3 Fig., 5 Tab, 7 Ref, 1 Append.

Descriptors: *Sampling strategy, *River flow, *Pollutant transport, Event response rivers, Stable response rivers, Suspended sediments, Phosphorus, High flow.

Estimates of the amount of pollutants which are carried by rivers from land sources to receiving water bodies are calculated from measurements of river flow rate and pollutant concentration. River flow can be measured frequently, but pollutant concentration will usually be sampled infrequently during the period of transport. A strategy is developed for sampling the pollutant concentration so that the errors in the transport estimates are minimal. Two types of rivers exist: event response rivers where suspended sediment concentrations and sediment absorbed parameters increase with increasing flow; and stable response rivers where suspended sediment and adsorbed parameter concentrations do not increase with increasing flow. Each type of river requires its own sampling strategy. High flow events must be sampled on event response rivers to obtain reliable suspended sediment and total phosphorus flux estimates. The best method to calculate the flux with this data is an interval method. If these events are not sampled, fluxes will be underestimated by 15%-30%. Event sampling is not important for event response rivers which are impacted by point sources. For stable response rivers and parameters which do not change with flow, event sampling is not required. (Moore-IVI)
W84-04050

SEVERAL METHODS FOR DISCHARGE MEASUREMENTS OF FLOODS

Faculty of Civil Engineering Sciences, Split (Yugoslavia). O. Bonacci Hydrological Sciences Journal, Vol. 28, No. 4, p. 513-524, December, 1983. 4 Fig., 1 Tab, 15 Ref., 1 Append.

Descriptors: *Flood discharge, *Flood hydrographs, *Integrated method, Rising float method, Flow discharge, Floods.

Flow discharge measurements during floods are of considerable importance, but particularly difficult to obtain. In addition, such measurements are very expensive and often the lives of the people carrying them out are endangered. Three methods of discharge measurement during floods are described: the integrated method; discharge measurements of the total flood hydrograph; and rising float methods. Each method is suitable for a particular type of river, and the choice of method is left to the people engaged in measurements. Hydrological practice (especially in developing countries) shows that there is a significant lack of information on discharge in flood periods, and it is known that even very complex methods and precise equipment very often prove inadequate. Therefore, relatively simple measurement methods using standard equipment which

make it possible to shorten the period of metering and to make contact with the river as brief as possible, are recommended. The rising float technique entirely eliminates contact between the staff and the water, and this seems to be one of the advantages governing its application in the future. (Moore-IVI)
W84-02829

SOIL SAMPLING QUALITY ASSURANCE USER'S GUIDE (PB-84-198621)

Barth, D.S.; Mason, B.J. (Nevada Univ. Las Vegas (USA)). May 1984. 113 p. NTIS, PC A06/MF A01.

The inherent inseparability of a cost-effective Soil Sampling Quality Assurance/Quality Control (AQ/QC) Plan for the objectives of a soil monitoring program is emphasized. Required precisions and confidence levels for the data cannot be defined until the decisions which will be made on the basis of the data are clearly stated and the consequences of making Type I (false positive) or Type II (false negative) errors are weighted. Statistical considerations are presented with special attention to analyses of variance of soil monitoring data, methods of calculating required numbers of soil samples to achieve desired precisions and confidence levels, possible applications of Kriging, and assignment of control limits to QA/QC data. The value of an exploratory or preliminary study to the cost-effective achievement of both the soil monitoring objectives and the objectives of the Soil Sampling QA/QC Plan is strongly emphasized. The value of developing a hypothetical model to estimate the distribution in space and time of soil pollutants and thus to assist in the design of the monitoring network is discussed. Methods for determination of the number and locations of soil sampling sites; sample collection methods and procedures to include frequency of sampling; sample handling to include labeling, preservation, preparation for analysis, and transport; together with QA/QC aspects are presented and discussed. Finally, the importance of systems audits and training to the achievement of soil sampling QA/QC objectives is presented and discussed.

SURVEY OF STATE WATER QUALITY MONITORING PROGRAMS

Perry, J. A.; Ward, R. C.; Loftis, J. C.. (Univ. of Minnesota, St. Paul). Environmental Management; 8: No. 1, p. 21-26 (Jan 1984).

This article reports results of a survey of all fifty state water quality monitoring programs. Twenty questions were asked in the general areas off fixed-station monitoring, special studies, and biological monitoring. Each state was contacted by telephone at least twice during the survey. Fixed-station monitoring is conducted by 48 of 50 states. An average of 75 stations per state are sampled, generally on a monthly basis. There is a large variation in the way data are analyzed by the states; water quality indices and plots of concentration or loading over time are the most common methods. All but three states conduct special studies, but only seven repeat the studies on a regular basis. Special studies are generally problem specific as opposed to basin oriented. Biological monitoring is performed by 33 states; however, this is an area in which budget cuts are having a noticeable impact. In some cases, biological monitoring is being completely eliminated or suspended. Macroinvertebrate sampling is performed quarterly to biannually by 50% of the states; 75% of the states that sample macroinvertebrates do so annually. Periphyton sampling is performed by 33/ of the states. Over 50% of the states are in the process of revising, or have revised, their monitoring program during the past five years. However, only four states had a detailed rationale and operating procedure for the entire monitoring system. Results of the survey are, therefore, averages of existing monitoring programs.

THE EFFECTS OF CURVATURE IN SUPERCRITICAL SIDE WEIR FLOW

Sheffield City Polytechnic (England). Dept. of Civil Engineering. D. J. Balm-forth and E. J. Sarginson. Journal of Hydraulic Research, Vol. 21, No. 5, p. 333-343, 1983. 6 Fig., 1 Tab, 9 Ref.

Descriptors: *Curvature, *Supercritical flow, *Weirs, Mathematical models, Side weirs, Water depth, Flow discharge, Channel slope, Critical depth.

A method for analyzing supercritical flow in a channel fitted with a side weir has been developed and tested against experimental data. Results of the experimental program have established the conditions under which supercritical flow occurs along a side weir, and showed that in cases where the flow upstream of the weir is subcritical the drawdown to supercritical flow produces sufficient curvature of the streamlines to affect the vertical pressure distribution. Modification of the differential equation to allow for curvature effects has significantly improved the accuracy of computation of depths and discharges. The depth at the upstream end of the weir is shown to be a function of the upstream critical depth, the weir crest height and the slope of the channel, and the rate of change of surface curvature along the upstream portion of the weir is found to depend on the upstream critical depth. Apart from these relationships little use is made of empirical formulae in analysis, so that the method may be applied to any side weir where supercritical low occurs.
W84-03165

VADOSE ZONE MONITORING FOR HAZARDOUS WASTE SITES. (PB-84-212752)

Everett, L.G.; Wilson, L.G.; Hoylman, E.W. (Kaman Tempo, Santa Barbara, CA (USA)). Oct. 1983. 279 p. NTIS, PC A17/MF A01.

This book describes the applicability of vadose zone monitoring techniques to hazardous waste site investigations. More than 70 different sampling an nonsampling vadose zone monitoring techniques are described in terms of their advantages and disadvantages. Physical, chemical, geologic, topographic, geohydrologic, and climatic constraints for vadose zone monitoring are quantitatively determined. Vadose zone monitoring techniques are categorized for premonitoring, active, and postclosure site assessments. Waste disposal methods are categorized for piles, landfills, impoundments, and land treatment. Conceptual vadose zone monitoring approaches are developed for specific waste disposal method categories.

A COMPARISON OF CHEMICAL LOAD ESTIMATION ALGORITHMS USING DATA OBTAINED BY SAMPLING FOUR SOUTH AFRICAN RIVERS AT VARYING FREQUENCIES

Hydrological Research Inst., Pretoria (South Africa). D. C. Grobler, C. A. Bruwer, P. J. Kemp, and G. C. Hall.
Water SA, Vol. 8, No. 3, p. 121-129, July, 1982. 8 Fig., 2 Tab.

Descriptors: *Pollution load, *Sampling, Rivers, Water quality, *Algorithms, *South Africa, Nitrates, Phosphates, Dissolved solids, Chlorides, Suspended solids, Pollutant identification, Vaal River, Balfour River, Blinkwater River, Orange River.

Six algorithms for calculating constituent loads from continuous flow records and discrete constituent concentration records were compared using data from four rivers in South Africa. No one algorithm was superior in all cases. The best algorithm had to be selected by considering both the type of constituent (conservative, nonconservative or suspended solids) and the sampling frequency. Generally, the load estimation algorithms overestimated conservative constituents (total dissolved solids and chlorides) loads, underestimated suspended solids loads, underestimated suspended solids loads, slightly overestimated nitrate loads and slightly underestimated phosphate loads. When sampling frequency was reduced in the dry season, accuracy of load estimations was not adversely affected. (Cassar-FRC)
W83-01825

A GENERAL STOCHASTIC MODEL FOR PREDICTING BOD AND DO IN STREAMS

North Carolina Univ. at Charlotte, Dept. of Mathematics. S. D. Damaskos and A. S. Papadopoulos.
International Journal of Environmental Studies, Vol. 21, No. 3/4, p. 229-237, October, 1983. 7 Fig., 10 Ref.

Descriptors: *Stochastic process, *Biochemical oxygen demand, Dissolved oxygen, Streams, Predicting, Forecasting, Oxygen, Sedimentation, Absorption, Path of pollutants, Model studies.

The stochastic model presented in this study is a random differential equation. The solution process is discussed. An example and computation are given indicating how the results may be used to study the statistical properties of the biochemical oxygen demand (BOD) and dissolved oxygen (DO) processes at any point down the stream from a source of pollution. It is assumed that there are five major activities in the stream: the pollution and dissolved oxygen are decreased by bacterial action; the dissolved oxygen is increased due to the process of reaeration at a rate proportional to the DO deficit; the BOD is only decreased by sedimentation and absorption at a rate proportional to the amount of pollution present; the pollution is increased from small sources along the stretches of stream; and the DO is decreased at a given rate in ppm per day. (Baker-IVI)
W84-04657

A MODELING APPROACH FOR STORM WATER QUANTITY AND QUALITY CONTROL VIA DETENTION BASINS

Princeton Univ., NJ. Dept. of Civil Engineering. R. A. Ferrara and A. Hildick-Smith.
Water Resources Bulletin, Vol. 18, No. 6, p. 975-981, December, 1982. 7 Fig., 5 Tab., 7 Ref.

Descriptors: *Storm water, *Detention reservoirs, *Urban hydrology, Model studies, Mathematical models, Storm wastewater, Design criteria, Nonpoint pollution sources, Water quality control, Water management.

A mathematical model is presented to help designers plan storm water detention basins for the dual purposes of storm water quality and quality control. Results show that, for a given basin, removal increases as storm frequency increases, i.e., storm size decreases. For large storms, particles have less time and greater depths over which to settle in the basin. The degree of pollutant removal for any particular constituent (for example, solids, COD, total Kjeldahl nitrogen, and total phosphorus) is a function of the particle size for that constituent. For particles <1 micron little removal is obtained; for particles >105 microns, nearly complete removal is obtained. Solids removal is high; total P removal is low. The design procedure is illustrated with a hypothetical 1 sq mi watershed undergoing development. (Cassar-FRC)
W83-03147

A STOCHASTIC MODEL FOR A SMALL-TIME-INTERVAL INTERMITTENT HYDROLOGIC PROCESS

Missouri Univ., Rolla, MO, Dept. of Civil Engineering. C. D. Morris.
Journal of Hydrology, Vol. 68, p. 247-272, 1984. 7 Fig., 8 Tab, 4 Ref.

Descriptors: *Stochastic models, *Precipitation, Rainfall, Model studies, Markovian precipitation distribution, Boneyard Creek, Morrow plots.

One of the major problems facing hydrologists is the lack of long-term records of precipitation and streamflow. Simulation of hydrologic records by means of stochastic modeling is a commonly accepted statistical procedure to extend the record. A methodology is developed for the generation of intermittent small-time-interval (15 min) precipitation. The methodology consists of three components: a probabilistic wet-and-dry sequence component; a Markovian precipitation distribution component; and a regressive spatial-distribution component. The method is demonstrated by application to an actual precipitation network, the Boneyard Creek rainage network in Champaign-Urbana, Illinois. The trend in frequency of precipitation amounts from the 89 yr Morrow plots data are produced by the model using 13 year of historical data. The model reproduces the mean and variance of storm precipitations, the storm lengths, the dry-period lengths, the transition pro-

bability distributions of the precipitations and the autocorrelation structure of the network data. (Baker-IVI)
W84-03346

A STOCHASTIC MODEL FOR SUSPENDED SOLIDS SETTLING VELOCITY

New Jersey Agricultural Experiment Station, New Brunswick, NJ, C. G. Uchrin and W. J. Weber, Jr.
Journal of Environmental Science and Health, Part A, Vol. 18, No. 1, p. 103-124, 1983. 18 Fig., 12 Ref.

Descriptors: *Suspended solids, *Settling velocity, *Sedimentation rates, Clays, Model studies, Particulate matter, Suspended sediments, Flocculation, *Stochastic process.

A stochastic model for representing particle fall velocity distribution for suspended sediments was developed. Particle fall velocity was assumed to follow a log-normal distribution. Flocculation effects were accounted for by distribution parameters. The model allows use of steady state equations for quasi-time variable analyses. A 10 ft. high, 5 inch deep column was used to empirically determine the fall velocity distribution parameters. Results of column settling tests with samples from several rivers and streams agreed well with predicted results. (Cassar-FRC)
W83-03158

AGGREGATION AND ESTIMATION FOR LOW-ORDER PERIODIC ARMA MODELS

Colorado State Univ., Fort Collins, CO, Dept. of Recreation Resources. A. V. Vecchia, J. T. Obeysekers, J. D. Salas, and D. C. Boes.
Water Resources Research, Vol. 19, No. 5, p. 1297-1306, October, 1983. 10 Fig., 6 Tab., 8 Ref., NSF grant CEE-8110782.

Descriptors: *Hydraulic models, *Seasonal variation, Estimating, Aggregates, Statistical studies, Time series analysis.

An aggregation approach is presented in which the seasonal time series is modeled and then aggregated, producing a specified compatible model for the aggregated series. The assumed periodic (seasonal) model is defined and the resulting aggregated model is derived. Parameter estimation is considered and some results on the goodness, as quantified by bias and variance, of the proposed estimators are given. A significant grain in the precision of the estimators at the aggregated level is noted when the seasonal data and its model are used as opposed to the aggregated (annual) data and its model. (Baker-IVI)
W84-02769

AN EVALUATION OF THREE PESTICIDE RUNOFF LOADING MODELS

Environmental Research Lab., Athens, GA. M. N. Lorber and L. A. Mulkey.
Journal of Environmental Quality, Vol. 11, No. 3, p. 519-529, 1982. 2 Fig., 17 Tab., 22 Ref.

Descriptors: *Pesticides, *Nonpoint pollution sources, *Sediment transport, Atrazine, Toxaphene, Insecticides, Model studies, Runoff, Fate of pollutants, Agricultural watersheds, Erosion, Sediment yield, Cotton, Agricultural runoff management model, Continuous pesticide simulation, Chemical runoff and erosion from Agricultural management Systems.

Three nonpoint source runoff models were compared for their ability to predict the movement of pesticides (toxaphene and atrazine) from watersheds. The models were Agricultural Runoff Management (ARM), Continuous Pesticide Simulation (CPS), and Chemical, Runoff, and Erosion from Agricultural Management Systems (CREAMS). Total toxaphene losses (g per ha for a 12-month period) from a cotton plantation on a 15.6 ha Mississippi Delta watershed were: ARM, 105.98; CPS, 96.67, CREAMS, 105.85, and observed, 96.53. Erosion (tons per ha) for the same site and period were: ARM, 25.73; CPS, 27.93; CREAMS, 19.63; and observed, 26.25. Runoff predictions were within 15% of observed values. Prediction of peak events varied widely among the models, with CREAMS values for runoff, soil loss, and toxaphene loss generally less than half those of the ARM model, and CPS values less than 40% of ARM values. Predicted atrazine losses from a small Southern Piedmont watershed were very similar for all three models. (Cassar-FRC)
W84-00584

ANALYSIS OF SURVEY DATA ON THE CHEMISTRY OF TWENTY-THREE STREAMS IN THE CHEASAPEAKE BAY WATERSHED. SOME IMPLICATIONS OF THE IMPACT OF ACID DEPOSITION. FINAL REPORT

A. Janicki and R. Cummins, (Martin Marietta Corp., Baltimore, MD (USA). Environmental Center). Dec. 1983. p. 78, NTIS, PC A05/MF A01.

See also PB83-249375.

A survey of the chemistry of 23 streams within the Cheasapeake Bay watershed was conducted in the spring of 1983 to determine whether a potential for changes in water chemistry due to atmospheric inputs of acidic materials exists in any of these streams. Sampling was conducted weekly through the months of March and April. Three streams were identified as being likely affected by acid inputs due to relatively high H(+) and SO4(-2) concentrations and low alkalinities: Stockett's Run, Lyons Creek, and Muddy Creek. Elevated dissolved aluminum concentrations were observed in some Eastern Shore streams and are likely related to the predominance of clay soils in their watersheds.

APPLICATION OF STOCHASTIC DISSOLVED OXYGEN MODEL

Gore and Storrie Ltd., Toronto (Ontario). R. J. Dewey.
Journal of Environmental Engineering. Vol. 110, No. 2, p. 412-429, April, 1984. 9 Fig., 2 Tab, 21 Ref.

Descriptors: *Dissolved oxygen, *Model studies, *Stochastic process, Mathematical models, Water pollution control, Water quality control. Pollution load, Receiving water.

A stochastic dissolved oxygen river model is developed based on modifications of a set of random differential equations after Streeter and Phelps. The method uses randomly generated rate constraints and input parameters which are described by probability distributions determined from survey data means and their standard deviations to generate the probable dissolved oxygen levels in a river. The model is used to predict the effect of plants on the dissolved oxygen level in the receiving river. The model is applied to the Thames River, London, Ontario, to determine if flow augmentation would reduce the number of episodes of low dissolved oxygen in the river during the low flow seasons. In addition, the model was used to test if improved treatment in the water pollution control plants would alleviate the low dissolved oxygen level in the river. The model results indicate that flow augmentation is not required if the water pollution control plants produce improved effluent. (Author's abstract)
W84-04598

APPROXIMATE METHOD FOR PARTITIONING DAILY STREAMFLOW DATA

Georgia Coastal Plain Experiment Station, Tifton, A. Shirmohammad, W. G. Knisel, and J. M. Sheridan.
Journal of Hydrology, Vol. 74, No. 3/4, p. 335-354, November, 1984. 7 Fig., 7 Tab, 24 Ref.

Descriptors: *Storm seepage, *Streamflow, *Storm runoff, *Georgia, Coastal Plain, Rainfall, Watersheds, Drainage area.

Subsurface flow constitutes an important component of the hydrologic cycle, and a method which would use commonly available daily hydrologic data to make estimates of subsurface flow components would be a valuable tool for the water-resource planner. An approximate method for partitioning daily total streamflow volumes into storm runoff and subsurface flow components was developed and tested with streamflow data from ten research watersheds, 2.6 to 1494.43 sq km in size, in the Coastal Plain of Georgia. Daily rainfall an streamflow data can be used to obtain reasonable estimates of storm-runoff and subsurface flow amounts. The empirical approach underestimates the storm-runoff time base for large watersheds. A power function was developed which can be used to determine the storm-runoff time base for watersheds in the Coastal Plain physiographic region. The contribution of subsurface flow to total streamflow (60-80%) represents a significant component of the hydrological cycle and consequently a significant water resource in the basins of area studied. Subsurface flow contribution to total streamflow in the Coastal Plain physiographic region is relatively independent of the size of drainage area, and data from small unit source areas give good representation of partitioned flows on much larger mixed-cover watersheds. (Moore-IVI)
W85-03758

APPROXIMATING POLLUTANT TRANSPORT TO GROUND WATER

Robert S. Kerr Environmental Research Lab., Ada, OK. C. G. Enfield, R. F. Carsel, S. Z. Cohen, T. Phan, and D. M. Walters.
Ground Water, Vol. 20, No. 6, p. 711-722, November-December, 1982. 3 Fig., 5 Tab, 35 Ref.

Descriptors: *Groundwater pollution, *Solute transport, *Model studies, Pesticides, Degradation, Aldicarb, DDT, Path of pollutants.Three models are presented for estimating transport of organic chemicals through soils to groundwater. The models consider mobility and first other degradation. The first model calculates linear sorption/desorption of the pollutant and first order degradation within considering dispersion. The second is similar but also considers dispersion. The third considers nonlinear sorption following a Freundlich equation and first order degradation but does not consider dispersion. The models are compared to field data for the pesticides aldicarb and DDT. Based on the correlation between field data and model projections the approach should be adequate to make environmental decisions evaluating the potential hazard of nonionic organics to the ground water. Modification to one of the equations would be necessary to evaluate ionic or charged compounds. The sensitivity of the model to degradation rate shows the need to describe degradation and the parameters affecting degradation accurately. Each of the models has certain advantages, and the appropriate model should be selected based on individual need. (Baker-IVI)
W85-00349

BEWARE OF SPURIOUS SELF-CORRELATIONS

Fisheries and Marine Service, Winnipeg (Manitoba). Freshwater Inst. B. C. Kenney.
Water Resources Research, Vol. 18, No. 4, p. 1041-1048, August, 1982. 8 Fig., 16 Ref.

Descriptors: *Correlation analysis, *Regression analysis. *Mathematical studies, Spurious self-correlation, Graphical analysis, Statistics, Data processing, Hydraulics, Hydrology.

Spurious self-correlations arise when two parameters (sums, differences, ratios, products, or single variables) used in a linear regression analysis have some element in common. To illustrate this, perfect but spurious correlations between two such parameters are produced with random numbers. The largest magnitude of spurious self-correlation coefficient occurs for data sets where there is much greater dispersion in the data for the common term relative to the unique terms in the parameters. Logarithmic transformations or log-log plots enhance spurious self-correlations of ratios and products. Several examples of spurious self-correlations in the literature are given as examples: Vollenweider (1976), a plot of a sedimentation constant vs. mean depth of lakes; Bell et al. (1980), the relationship between the coefficient of variation of soil moisture and the mean soil moisture; Morgan (1980), a relationship between weight-specific

epiphyte assimilation rate and shrimp weight; and Bamstedt and Skjoldal (1980), RNA weight in zooplankton divided by the dry weight of the specimens plotted against the dry weight of the specimens. In these illustrations ratios have been plotted against their own denominators. (Cassar-FRC)
W83-01713

CALIBRATION OF NPS MODEL LOADING FACTORS

Camp, Dresser and McKee, Inc., Annandale, VA. J. P. Hartigan, T. F. Quasebarth, and E. Southerland.
Journal of Environmental Engineering, Vol. 109, No. 6, p. 1259-1272, December, 1983. 8 Fig., 5 Tab, 8 Ref.

Descriptors: *Calibrations, *Nonpoint pollution submodel, *Load distribution, Computer models, Nonpoint pollution sources, Pollution load, Land use, Simulation analysis.

The use of continuous simulation models can facilitate the development of loading factors and loading projections because they deterministically account for the impact of hydrometeorologic and physiographic differences on nonpoint pollution loadings: NPS continuous simulation model calibrated to 11 single-land use watersheds in Chesapeake Bay drainage area derived nonpoint pollution loading factors (total N and total P) for rural, agricultural, and urban land use categories. Flow, rainfall, and nonpoint pollution monitoring records for each test watershed cover approximately 1-1.5 years. Parameter adjustments for calibration of both the hydrologic and nonpoint pollution submodels relied upon NPS model executions with continuous 15-minute rainfall record covering the entire monitoring period. Parametric and nonparametric statistics were used to assess goodness-of-fit for nonpoint pollution loading calibration. In light of the higher power than normal statistics for datasets characterized by small sample sizes and skewed distributions, nonparametric statistics are recommended for goodness-of-fit assessments for nonpoint pollution loading models. Each test watershed site of calibrated NPS loading factors for total N and total P covered forest, pasture, high tillage cropland, low tillage cropland and urban residential land use categories. Simulated annual unit area loads for each land use are compared for years of normal and above-average rainfall. (Murphy-IVI)
W84-03093

CHEMICAL TRANSPORT THROUGH THE SOIL SYSTEM

C. J. Emerson, B. Thomas, Jr., R. J. Luxmoore. (Oak Ridge National Lab., TN (USA)). 1984. Contract AC05-85OR21400. p. 17. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE84015399.
From Summer computer simulation conference; Boston, MA, USA (23 July 1984).

CADIL, a computer model simulating chemical transport through soils, was developed from the SCEHM model (an earlier soil chemical model developed by Begovich and Jackson at Oak Ridge National Laboratory (ORNL/NSF/EATC-16)] and was linked to AGTEHM [a terrestrial ecosystem hydrology model for agricultural applications developed by Hetrick, Holdeman, and Luxmoore at Oak Ridge National Laboratory (ORNL/TM07856)]. CADIL simulates deposition, infiltration, adsorption, and degradation of chemicals in the soil. A soil temperature model is included to model the effect of temperature on chemical degradation. Both macropore and matrix flows of chemicals in soil water are modeled. The theory and model algorithms are described. The model is applied to an example case to show parameteric effects. 11 Ref., 2 Fig., 2 Tab.

CLIMATOLOGICAL WATERSHED CALIBRATION

Forest Research Inst., Kepong (Malaysia). A. R. H. Nik, R. Lee, and J. D. Helvey.
Water Resources Bulletin, Vol. 19, No. 1, p. 47-50, February, 1983. 2 Fig., 3 Tab., 5 Ref.

Descriptors: *Precipitation, *Streamflow, *Forest management, Water resources development, Water supply, Water quality, Climate, Watersheds, Evaporation, *West Virginia, Appalachian Mountains, Mountains.

The hypothesis that climatic data can be used to develop a watershed model so that streamflow chanes following forest harvest can be determined was investigated. Variables which were measured included precipitation, daily maximum and minimum temperature, and concurrent relative humidity. Computed variables included humidity deficit, saturated vapor pressure, and ambient vapor pressure. The high degree of correlation between annual precipitation and discharge suggests a linear relationship and implies similar watershed storages among hydrologic years. Thus annual discharge must be influenced more by seasonal factors such as precipitation and evaporative demand than on gross year to year differences in soil water storage. Moreover, whereas annual stream flow totals or averages are relatively steady, seasonal patterns of streamflow and the climatic variables of temperature and humidity deficit are obviously cyclic. This points directly to a deterministic relation between evaporation and streamflow and suggests the need for some adjustment to achieve functional synchronization of the seasonal cycles of precipitation and streamflow. It is concluded that climatological calibration appears to be a viable approach under special circumstances, such as when only one watershed is available for study. However, the paired watershed approach is expected to remain the preferred method for determining the effects of forest management on the water resource because of its simplicity and accuracy. (Baker-FRC)
W84-00095

COMPARATIVE PERFORMANCE OF TWO RUNOFF MODELS ON GRASSLAND WATERSHEDS

Oklahoma State Univ., Stillwater, OK,Dept. of Agricultural Engineering. C. S. Pathak, F. R. Crow, and R. L. Bengston.

Transactions of the American Society of Agricultural Engineers, Vol. 27, No. 2, p. 397-402 and 406, March-April, 1984. 5 Fig., 6 Tab, 10 Ref.

Descriptors: *Model studies, *Rainfall-runoff relationships, USDAHL model, CREAMS model, Breakpoint rainfall option, Grassland, Watersheds, Simulation, Hydrologic models.

The relative performances of the USDAHL model and the CREAMS hydrology model (Breakpoint rainfall option) were compared on four grassland watersheds ranging in area from 6.3 to 83 ha. The USDAHL model simulated monthly runoff more accurately than the CREAMS model on all watersheds. Watershed size and soil homogeneity were factors in simulation accuracy. Both models simulated monthly runoff more accurately on the two small watersheds (6.3 and 7.8 ha) with relatively homogeneous soils than on the two larger watersheds (37 and 83 ha) with heterogeneous soils. Compared with observed runoff the CREAMS model underestimated monthly runoff during the cool season months and overestimated during the summer months, especially in August. The simulation errors were especially serious on the larger watersheds. (Baker-IVI)
W85-01183

CONFIRMATION OF WATER QUALITY MODELS

Duke Univ., Durham, NC. School of Forestry and Environmental Studies. K. H. Reckhow and S. C. Chapra.
Ecological Modeling, Vol. 20, No. 2/3, p. 113-133, November, 1983. 8 Fig., 1 Tab., 52 Ref.

Descriptors: *Water quality, *Model studies, *Simulation, Statistical analysis, Mathematical models.

Water quality simulation models, whether descriptive or predictive, must undergo confirmatory analyses if inferences drawn from the models are to be meaningful. Current practices in the confirmation of simulation models are examined and criticized from this perspective. In particular, labeling this process 'verification' or 'validation' (truth) probably contributes to the often inadequate efforts, since these states are unattainable. The evaluation of scientific hypotheses, or water quality simulation models, may proceed according to inductive logic, the hypothetico-deductive approach, or perhaps according to a falsification criterion. The result of successful testing is at best confirmation or corroboration, which is not truth but rather measured consistency with empirical evidence. Inadequate model confirmation increases the risks associated with the application of the model. Model confirmation costs must be compared with the risk resulting from the use of an unconfirmed model. If confirmation is to be meaningful, rigorous statistical tests must be applied, and calibration-independent data are needed. A number of plausible candidate models (or model sub-routines) should undergo confirmation. Comparison of the performance of the candidates aids the modeler in the determination of the degree of confirmation. (Moore IVI)
W84-02538

COUPLING OF GROUNDWATER AND OPEN-CHANNEL FLOW

Waterloopkundig Lab., Delft (Netherlands). J. I. Crebas, B. H. Gilding, and J. W. Wesseling.
Journal of Hydrology, Vol. 72, No. 3/4, p. 307-330, June, 1984. 6 Fig., 1 Tab., 23 Ref.

Descriptors: *Groundwater movement, *Open-channel flow, *Hydrologic models, *Drainage, Model studies, Precipitation, Computer models, Hydrologic budget, Seepage.

A physically-based hydrologic response model was developed that incorporates drainage and the interaction of groundwater and open-channel flow; the model is called PREDIS for precipitation-discharge. The self contained computer module for groundwater flow which forms one of the couples for the exchange phenomena is based upon a standard two dimensional regional technique for groundwater modeling. The module for open channel flow which forms the other couple is a numerical scheme for solving the one-dimensional Saint-Venant flow equations. Two classes of exchange were distinguished. The first is concerned with the influence of minor conduits which require too much refinement to be modeled on an individual basis, but amalgamated make an important contribution to the water budget of a region on an areal basis. The second class of exchange is direct seepage from or into the larger waterways in which the flow is significant and is modeled as a distinct hydrologic process. A theory for treating the exchange phenomena was developed. The basis is formed by the Hooghoudt-Ernst formula of drainage design and the theory of additional seepage resistances. The main technical hurdle was the coupling of the two fundamentally incompatible numerical schemes for groundwater and open-channel flow in such a way that a conservative water balance is maintained. (Collier-IVI)
W85-01615

DISTRIBUTION OF TOXIC SUBSTANCES IN RIVERS

Princeton Univ., NJ. Dept of Civil Engineering. P. R. Jaffe, F. L. Parker, and D. J. Wilson
Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 108, No. EE4, p. 639-649, August 1982. 5 Fig., 7 Tab., 7 Ref.

Descriptors: *Sampling, *Pesticides, *Vertical distribution, *Pollutant identification, Statistical analysis, Organic compounds, Chlorinated hydrocarbons, Kinetics, Probability distribution, Fate of pollutants, Nested analysis, Adsorption, Suspended sediments, Aldrin, Endrin, Chlordane, Hexachlorobenzene, Rivers, Heptachlor, Dieldrin, Solubility, *Tennessee, Wolf River, Memphis.

A statistical sampling design was used to determine the vertical distribution of hydrophobic organic pollutants in a river. Samples were collected in the Wolf River, Memphis,

Tennessee, downstream of a dump used for disposal of pesticides manufacturing wastes before its closing 20 years ago. Since these substances were expected to have a nonhomogeneous vertical distribution due to density differences or adsorption on suspended sediments, samples were taken at different depths (10 each on the surface, middepth, and bottom at each location) to analyze the variance on a nested design. The vertical distribution of aldrin and suspended sediment was not uniform, but all other chlorinated compounds studied (hexachlorobenzene, heptachlor, dieldrin, chlordane, and endrin) had uniform vertical distributions. A study of grab sample probability distributions showed that log-normal distribution gave better descriptions of the grab sample distribution than normal adsorption. Endrin showed the largest departure from normal distribution. Mean concentrations of the pesticides in bottom sediments were as high as 585 ng per g except for aldrin, which had unrealistically high levels, believed to be an interference during analysis. Pesticides were found absorbed on suspended sediments, adsorbed on fine sediments, and in solution. No attenuation of the pesticides with distance was seen (possibly due to additional sources or resuspension). However, these compounds could have decay coefficients as high as 0.34 per km without being detected. Partition coefficients ranged from zero to 6 ng per g per liter, not including aldrin. (Cassar-FRC)
W83-01902

DYNAMIC ADVECTIVE WATER QUALITY MODEL FOR RIVERS

Ohio State Univ., Columbus, OH, Dept. of Civil Engineering. K. W. Bedford, R. M. Sykes, and C. Libicki.
Journal of Environmental Engineering, Vol. 109, No. 3, p. 535-554, June, 1983. 5 Fig., 2 Tab., 34 Ref.

Descriptors: *Water quality, *Storm runoff, *Mathematical models, Hydrodynamics, Plankton, Sedimentation, Diffusion, Light effects, Turbulence, Biochemical oxygen demand, Nitrogen, Orthophosphate, Olentangy River, Ohio.

A dynamic water quality model for storm induced flows in rivers is presented. The hydrodynamic portion is solved by a four-point implicit Newton-Raphson procedure, while the water quality code is formulated with a Holley-Preissmann nonlinear formulation. The water quality model represents the effects of biodegradation by plankton, sedimentation, and diffusion of material into the benthos by a single turbulence dependent decay term. Eight constituents are employed and the effects of light shading are considered. Two simple tests were used to provide simple initial calibrations. The first test, the propagation of a Gaussian wave, demonstrated the necessity of higher order treatment of the water quality numerical analog. The second test was a steady state test of the water quality model against data from the Olentangy River. The minimum kinetic structure required for Ohio streams should include CBOD, organic nitrogen, ammonia nitrogen, nitrate nitrogen, and orthophosphate. (Author's abstract)
W84-01767

EFFECT OF CENSORING TRACE-LEVEL WATER-QUALITY DATA ON TREND-DETECTION CAPABILITY

Geological Survey, Reston, VA. R. J. Gilliom, R. M. Hirsh, and E. J. Gillroy.
Environmental Science and Technology, Vol. 18, No. 7, p. 530-535, July, 1984. 5 Fig., 1 Tab, 8 Ref.

Descriptors: *Trace levels, *Data interpretation, *Water quality, *Censored data, Monte Carlo experiments, Data collections, Simulation analysis, Statistical analysis, Detection limits.

Monte Carlo experiments were used to evaluate whether trace-level water-quality data that are routinely censored (not reported) contain valuable information for trend detection. Measurements are commonly censored if they fall below a level associated with some minimum acceptable level of reliability (detection limit). Trace-level organic data were simulated with best- and worst-case estimates of measurement uncertainty, various concentrations and degrees of linear trend, and different censoring rules. The resulting classes of data were subjected to a nonparametric statistical test for trend. For all classes of data evaluated, trends were most effectively detected in uncensored data as compared to censored data even when the data censored were highly unreliable. Thus, censoring data at any concentration level may eliminate valuable information. Whether or not valuable information for trend analysis is, in fact, eliminated by censoring of actual rather than simulated data depends on whether the analytical process is in statistical control and bias is predictable for a particular type of chemical analyses. (Author's abstract)
W85-01125

EFFECT OF CENSORING TRACE-LEVEL WATER-QUALITY DATA ON TREND-DETECTION CAPABILITY

Gilliom, R. J.; Hirsch, R.M.; Gilroy, E.J.(Geological Survey, Reston, VA).
Environmental Science and Technology; 18: No. 7, 530-535 (July 1984).

Monte Carlo experiments were used to evaluate whether trace-level water-quality data that are routinely censored (not reported) contain valuable information for trend detection. Measurements are commonly censored if they fall below a level associated with some minimum acceptable level of reliability (detection limit). Trace-level organic data were simulated with best- and worst-case estimates of measurement uncertainty, various concentrations and degrees of linear trend, and different censoring rules. The resulting classes of data were subjected to a nonparametric statistical test for trend. For all classes of data evaluated, trends were most effectively detected in uncensored data as compared to censored data even when the data censored were highly reliable. Thus, censoring data at any concentration level may eliminate valuable information. Whether or not valuable information for trend analysis is, in fact, eliminated by censoring of actual rather than simulated data depends on whether the analytical process is in statistical control and bias is predictable for a particular type of chemical analyses.

EFFECT OF SAMPLING UNCERTAINTY AND SPATIAL CORRELATION ON AN EMPIRICAL BAYES PROCEDURE FOR COMBINING SITE AND REGIONAL INFORMATION

Monash Univ., Clayton (Australia). Dept. of Civil Engineering. G. Kuczera.
Journal of Hydrology, Vol. 65, No. 4, p. 373-398, September, 1983. 5 Fig., 5 Tab., 20 Ref.

Descriptors: *Sampling. *Probabilistic process, Mathematical studies, Model studies, Spatial distribution, Hydrologic models.

The effect of sampling uncertainty and spatial correlation on the pooling of site and regional information is studied in the context of the empirical Bayes (EB) normal probability model, chosen because of its simplicity and generality. Because the EB model parameters must be evaluated from observed hydrologic data they are subject to uncertainty which can be considerable when samples are small and inter-site correlation exists. The procedures developed enable one to assess approximately the effect of uncertainty in these parameters. Hence, the gains that pooled inference can make over site or regional inference can be realistically evaluated and also the cases for which pooling of information is counterproductive can be identified. While the EB model assumes the sampling distribution and superpopulation are normally distributed, the results can be usefully employed in non-normal situations whenever a quadratic loss criterion is acceptable. In such instances, the EB procedure for pooling site and regional information is the best available one for the class of linear procedures with its risk being given by the pooled variance. (Baker-IVI)
W84-02457

ESTIMATES OF DISSOLVED AND SUSPENDED SUBSTANCE YIELD OF STREAM BASINS IN MICHIGAN

Geological Survey, Lansing, MI. Water Resources Div. T. R. Cummings.
USGS Water-Resources Investigations Report 83-4288, 1984. p. 57, 4 Fig., 5 Tab., 2 Ref.

Descriptors: *Water quality, *River basins, Streams, *Hydrologic data networks, *Regression analysis, Yield equations, *Great Lakes, *Michigan.

Water-quality data collected at 20 stations in Michigan were used to develop regression equations relating discharge to loads of 19 dissolved and suspended substances measured at each station. These equations and mean daily discharge were used to estimate long-term loads, which then were converted to estimates of drainage basin yields. These yields were compared to measured yields and to previous estimates. Fifty percent of the equations had standard errors of 22 percent or less; 90 percent had standard errors of 80 percent or less. Regression exponents indicate that the load increases as discharge increases in all cases, but for about two-thirds of the substances or properties the increase is less rapid than that of discharge. Seventy-eight percent of the nitrogen, phosphorus, and sediment loads, taken as a group, increase more rapidly than discharge. With respect to concentration, about 63 percent of the substances or properties decrease as discharge increases.
W85-01942.

ESTIMATING SEDIMENT YIELD FROM RANGELAND WITH CREAMS

Purdue Univ., Lafayette, IN. Dept. of Agricultural Engineering. G. R. Foster and L. J. Lane.
In: Proceedings of the Workshop on Estimating Erosion and Sediment Yield on Rangelands, Tucson, Arizona, March 7-9, 1981, Agricultural Reviews and Manuals ARM-W-26, June 1982, p. 115-119, 14 Ref.

Descriptors: *Rangelands, *CREAMS, *Soil erosion, *Sediment yield, *Mathematical models, Slopes, Deposition, Backwater, Sediment transport, Storms, Rainfall-runoff relationships, Agriculture.

The erosion/sediment yield component of CREAMS, a field-scale model for Chemicals, Runoff, and Erosion from Agricultural Management Systems, may be used to estimate sediment yield from small rangeland watersheds. The component operates on a storm-by-storm basis using rainfall erosivity, runoff volume, and a characteristic runoff rate. The erosion/sediment yield component of CREAMS was originally developed for agricultural fields but has sufficient generality to apply to rangelands, disturbed forest areas, construction sites, and surface mines. The component also applies to a broad range of conservation practices including conservation tillage, rotations, contouring, strip-cropping, terraces, grassed waterways, and small impoundments. It considers the influence of topographic features on erosion and deposition along concave, convex, and complex slopes; deposition by backwater at field outlets; and erosion and deposition in natural and constructed waterways. The model has overland flow, concentrated flow, and impoundment components to represent the major hydrologic, hydraulic, erosion, deposition, and sediment transport processes on field-sized areas. Validation studies have shown that the model gives reasonable results for agricultural areas with little or no calibration. (Moore-SRC)
W83-00103

ESTIMATION OF LOG NORMAL QUANTITIES: MONTE CARLO RESULTS AND FIRST-ORDER APPROXIMATIONS

Hokkaudo Univ., Sapporo (Japan). Dept. of Civil Engineering. K. Hoshi, J. R. Stedinger, and S. J. Burges.
Journal of Hydrology, Vol, 71, No. 1-2, p. 1-30, March 15, 1984. 1 Fig., 14 Tab, 51 Ref. NSF grant CME8010889.

Descriptors: *Log-normal quantiles, *Monte Carlo method, *Mathematical models, Flood frequency, Three-parameter log-normal distribution, Flood flow.

The three-parameter log-normal (LN3) distribution is often used to describe hydrologic data, particularly for synthetic streamflow generation and for flood frequency analysis. Monte Carlo estimates of the average bias and root mean square error achieved with different quantile estimation procedures for the three-parameter log-normal distribution allow a comparison of the method's performance. The maximum likelihood method, method of moments, and two quantile-lower-bound estimators in combination with two moments in real or in log space were considered. The maximum likelihood method and Stedinger's quantile-lower-bound methods provide more accurate estimators of the 1 and 10 percentiles of the distribution. No method was best for estimating the 99 and 99.8 percentiles. First-order approximations provide reasonable estimates of the estimators' sampling variance in most cases. All quantile estimators of the 99 or 99.8 percentiles of a flood-flow distribution were shown to yield design flood values which will be exceeded with probabilities substantially in excess of 1% and 0.2%, respectively. (Murphy-IVI)
W84-04299

ESTIMATION OF SKEWNESS OF HYDROLOGIC VARIABLES

George Washington Univ., Washington, D.C. International Water Resources Inst. V. Yevjevich and J. T. B. Obeysekera.

Water Resources Research, Vol. 20, No. 7, p. 935-943, July, 1984. 12 Fig., 3 Tab, 21 Ref., NSF grant CEE-7916817.

Descriptors: *Skewness, *Hydrology, Probability, Mathematical studies, Simulation.

Various methods of estimation of the skewness coefficient of hydrologic random variables are compared with respect to bias, variance, mean square error, and robustness. The underlying population distributions are limited to gamma (Pearson type 3) and log normal. The simulation results show that a new skewness estimator that uses the estimated covariance between the subsample mean and the subsample variance has a lesser bias than the ordinary skewness estimators. It may be used as a surrogate when the sample size is small and population skewness large. The superior estimates of skewness resulting from the maximum likelihood estimation of parameters of the known underlying distribution and robustness studies point to the importance of the correct inference on the type of underlying probability distribution function in hydrologic applications. (Author's abstract)
W85-02161

FOLIAR WASHOFF OF PESTICIDES (FWOP) MODEL: DEVELOPMENT AND EVALUATION

Environmental Protection Agency, Athens, GA. C. N. Smith and R. F. Carsel.

Journal of Environmental Sciences and Health, Vol. B19, No. 3, p. 323-342, 1984. 6 Fig., 5 Tab, 20 Ref.

Descriptors: *Pesticides, *Foliar washoff, *Model studies, Simulation, Leaves, Path of pollutants, Runoff, Carbaryl, Profenfos, Methyl parathion, permethrin, Toxaphene.

The Foliar Washoff of Pesticides (FWOP) Model was developed to provide an empirical simulation of pesticide washoff from plant lead surfaces as influenced by rainfall amount. To evaluate the technique, simulations by the FWOP Model were compared to those by the foliar washoff alogrithm of the Chemical, Runoff and Erosion from Agricultural Management Systems (CREAMS) Model. The two algorithms were linked individually to the Pesticide Runoff Simulator (PRS) for the comparison. Five years of test data from a Mississippi watershed were used to evaluate six insecticides (carbaryl, profenofos, methyl parathion, permethrin, phorate, and toxaphene). Initially, the FWOP model was used to evaluate the relative impact of chemical distribution (foliage versus soil) on the subsequent foliar washoff and soil surface contributions to runoff losses. Results indicated that runoff losses were low if all of the insecticide was applied to the foliage whereas high losses occurred if applied only to the soil. When an assumed application was distributed between the plant and soil (i.e., 90% to foliage and 10% to soil), predicted runoff losses compared well with observed field data (< 3% of the application rate). Except for toxaphene, the FWOP model generally predicted less washoff and subsequent runoff losses than the CREAMS approach. Simulated toxaphene washoff losses were in good agreement with observed field data. Statistical comparison of the two modeling approaches using the Kolmogorov-Smirnov test showed differences in the two cumulative frequency distributions for washoff but small differences for runoff. Average 5 year runoff losses, however, were greater using the CREAMS approach — by factors of 2, 3, and 3 for profenofos, methyl parathson and phorate, respectively. Results from this study will be useful for upgrading current exposure assessment models to more accurately address foliar washoff losses of pesticides as well as for assessing the impact of foliar-applied chemicals on environmental quality. (Author's abstract)
W85-01441

FREQUENCY DISTRIBUTIONS OF WATER QUALITY VARIABLES; RELATIONSHIPS BETWEEN MEAN AND MAXIMUM VALUES

Uppsala Univ. (Sweden). Limnologiska Institutionen. U. Heyman, S. O. Ryding, and C. Forsberg.

Water Research, Vol. 18, No. 7, p. 787-794, 1984. 3 Fig., 4 Tab., 17 Ref.

Descriptors: *Sweden, *Water quality, *Lakes, Probability, Chemical oxygen demand, Turbidity, Color, Hydrogen ion concentration, Nitrogen, Phosphorous, Suspended solids, Transparency, Chlorophyll a, Conductivity, Mathematical studies, Statistical analysis.

Frequency distributions of water quality variables have been analyzed by using about 950 samples from 25 Swedish meso- to hypertrophic lakes. By expressing all values as relative to their means, data from all the lakes could be pooled to datasets based on about 950 values for each variable. The distributions of COD, conductivity, pH and color were symmetrical with very high frequencies around 100% of the mean. The variables of total-N, total-P, suspended solids and Secchi disk transparency followed more skew distributions, while turbidity, chlorophyll a and molybdate reactive phosphorous (MRP) were markedly skewed. The inorganic nitrogen fractions had their highest frequency at or just above zero percent of the mean. Three probability density functions (pdf) namely beta, gamma and log normal distributions were fitted to the pooled data. There were two variables, color and conductivity, which did not fit to any of the pdf's but for the rest the null hypothesis could not be rejected at the 99.5% level. Frequency distributions for each lake demonstrated that for most variables one or two lakes showed distributions deviating from the pooled data pdf. There were no discernible trends among lakes and the number of rejections seemed to be randomly distributed. (Collier-IVI)
W85-00553

HYDROLOGIC DELINEATION OF NONPOINT SOURCE CONTRIBUTING AREAS

Science and Education Administration, University Park, PA. Northeast Watershed Research Center. W. J. Gburek.
Journal of Environmental Engineering, Vol. 109, No. 5, p. 1035-1048, October, 1983. 7 Fig., 19 Ref.

Descriptors: *Hydrologic delineation, *Nonpoint pollution sources, Land use, Regulations, Rainfall-runoff relationships, Surface flow, Surface runoff, Hydrodynamics, Simulation analysis.

Land-use regulations for reduction of nonpoint source pollution from surface-applied contaminants do not usually consider the differing hydrologic responses of land areas based on soil type, slope, proximity to the stream, and expected rainfall. To help overcome this shortcoming, one can define the area of a watershed contributing surface runoff directly to the stream as the result of any rain. Using design rainfalls and initial watershed soil moisture as input, a map can be drawn showing the return period with which any part of the watershed contributes surface runoff, and thereby potential nonpoint source pollution, to the stream. A small agricultural watershed in east-central Pennsylvania defines the restricted-use areas on a watershed and eliminates the subjective nature of commonly proposed land-use regulations by accounting for both the watershed characteristics and the probabilities controlling the generation of surface runoff and its direct affects on the stream. (Murphy-IVI)
W84-03086

IMPROVED PARAMETER INFERENCE IN CATCHMENT MODELS: 1. EVALUATING PARAMETER UNCERTAINTY

G. Kuczera.
Water Resources Research, Vol. 19, No. 5, p. 1151-1162, October, 1983. 12 Fig., 4 Tab., 33 Ref.

Descriptors: *Hydrologic models, *Catchment areas, *Statistical models, Runoff, Soil water, Model studies, Stochastic process.

A Bayesian methodology is developed to evaluate parameter uncertainty in catchment models fitted to a hydrologic response such as runoff, the goal being to improve the chance of successful regionalization. The catchment model is posed at a nonlinear regression model with stochastic errors possibly being both autocorrelated and heteroscedastic. The end result of this methodology, which may use Box-Cox power transformations and ARMA error models, is the posterior distribution, which summarizes what is known about the catchment model parameters. This can be simplified to a multivariate normal provided a linearization in parameter space is acceptable; means of checking and improving this assumption are discussed. The posterior standard deviations give a direct measure of parameter uncertainty, and study of the posterior correlation matrix can indicate what kinds of data are required to improve the precision of poorly determined parameters. Finally, a case study involving a nine-parameter catchment model fitted to monthly runoff and soil moisture data is presented. It is shown that use of ordinary least squares when its underlying error assumptions are violated gives an erroneous description of parameter uncertainty. (Author's abstract)
W84-02760

IMPROVED PARAMETER INFERENCE IN CATCHMENT MODELS; 2. COMBINING DIFFERENT KINDS OF HYDROLOGIC DATA AND TESTING THEIR COMPATIBILITY

G. Kuczera.
Water Resources Research, Vol, 19, No. 5, p. 1163-1172, October, 1983. 11 Fig., 7 Tab, 12 Ref., 2 Append.

Descriptors: *Hydrologic models, *Catchment areas, *Runoff, Mathematical models, Statistical methods, Rainfall-runoff relationships, Bayesian methodology.

Some of the parameters of catchment models fitted to runoff data are often poorly determined, thereby making the task of developing useful regionalization relationships more difficult. The approach taken here is based on the notion that the information in a rainfall-runoff record can be supplemented by observations of other hydrologic responses such as soil moisture and field studies of hydrologic responses such as interception. The Bayesian methodology is extended to utilize several kinds of hydrologic data in parameter inference, the goal being to improve the precision of poorly determined parameters.

The concept of compatibility is developed using statistical hypothesis tests. Different kinds of data are said to be compatible if differences between their fitted parameters are not statistically significant. A hierarchy of three levels of information is introduced to enable systematic checking for compatibility. The compatibility tests, proposed as statistical hypothesis tests, check whether differences between parameters inferred from different kinds of data are statistically significant. Application of this methodology to a case study indicates that the precision of poorly determined parameters fitted to runoff data can be substantially improved when runoff data are pooled with other kinds of hydrologic data. Before pooling different kinds of data (including split samples) it is essential to check their compatibility. When incompatible data are pooled, the ability of the catchment model to predict runoff can be undermined and also biases can be induced in the inferred parameters. (Moore-IVI)
W84-02761

INCREMENTAL DYNAMIC PROGRAMMING MAY YIELD SUBOPTIMAL SOLUTIONS

Hydro-Quebec, Varennes. A. Turgeon.
Water Resources Research, Vol. 18, No. 6, p. 1599-1604, December, 1982. 9 Fig., 3 Tab, 4 Ref.

Descriptors: *Dynamic programming, *Model studies, *Optimization, Reservoir operation.

Incremental dynamic programming, a procedure that permits the memory requirement of dynamic programming to be reduced, is widely used in water resources research. In some cases this method may produce a nonoptimal solution if the same state increment is used for every stage. A sample problem attempts to determine the maximum amount of water in storage in a reservoir at the beginning of each week, given that the river flow at a certain site must not exceed a given value. By changing the increment sizes in each stage, the desired results are obtained. (Cassar-FRC)
W83-02941

INTEGRATED METHODOLOGY FOR INSTREAM FLOW STRATEGIES

Duke Univ., Durham, NC. Dept. of Civil and Environmental Engineering. M. A. Medina, Jr.
Water Resources Research Institute Completion Report, North Carolina State Univ., Raleigh, NC, September, 1983. 142 p., 91 Fig., 19 Tab, 79 Ref.

Descriptors: Flow control, Stream fisheries, Streamflow, *Pollution load, Water quality, *Instream flow, Model studies, *Computer models, Simulation, *Computer programs, *North Carolina, Salem Creek, Path of pollutants, Water pollution sources, *Microcomputer programs.

An integrated methodology for instream flow strategies is presented, based on hierarchical package of computer models ranging from simple microcomputer programs to more complex mainframe simulation. The microcomputer programs are statistically based, and assume that both flows and pollutant concentrations are lognormally distributed for upstream sources, non-point sources and point sources. An extensive statistical analysis of nationwide data collected under the National Urban Runoff Program (NURP), as well as at the study site for the selected time series (Salem Creek, Winston-Salem, N.C. – November 1980 to August 1981), supports this assumption. The level of analysis progresses to an intermediate level: steady-state, continuous deterministic simulation. This level allows the representation of cause/effect (pollutant/water quality), coupled reactions.
W85-01951

INTERVENTION ANALYSIS OF WATER QUALITY RECORDS

Inland Waters Directorate, Vancouver (British Columbia). Water Quality Branch. P. H. Whitfield, and P. F. Woods.
Water Resources Bulletin, Vol. 20, No. 5, p. 657-668, October, 1984. 9 Fig., 4 Tab, 20 Ref.

Descriptors: *Water quality, *Water management, *Kootenai River, *Model studies, Stochastic hydrology, Water resources development.

The use of intervention analysis for statistically describing and modeling streamflow and water quality variables and the effects of impoundment on these variables are discussed. The intervention models were developed with data collected from June 1967 through February 1981 at the two stations on the Kootenai River immediately downstream from Libby Dam. In March 1972 the Kootenai River was impounded by Libby Dam in northwestern Montana to form Lake Koocanusa, a large reservoir operated to provide flood storage, hydroelectric power, and recreation benefits. The water quality of the Kootenai River downstream of the damsite was altered. The alternations are attributable to limnological process which took place within the reservoir that was created. The application of time series methods, in particular intervention models, allowed the monthly changes in water chemistry to be quantified, and tested for significance. The changes downstream were largely attributable to the depth of withdrawal from the reservoir and the reservoir's ability to store and mix various influent water masses. The preimpoundment and postimpoundment time series of discharge and six water quality variables were autocorrelated and exhibited strong seasonality. (Baker-IVI)
W85-03131

INVESTIGATION OF OUTLIERS IN ANNUAL MAXIMUM FLOW SERIES

Birmingham Univ. (England). Dept. of Civil Engineering. N. T. Kottegoda.
Journal of Hydrology, Vol. 72, No. 1/2, p. 105-137, April, 1984. 5 Fig., 9 Tab., 45 Ref.

Descriptors: *Outliers, *Maximum flow, *Annual distribution, Statistical analysis, Shapiro-Wilk test, Flood forecasting, Flood frequency.

Outlier detection procedures are reviewed under different hypotheses and assumptions on distribution. Tests of discordancy for detecting outliers are based on goodness of fit, kurtosis, skewness and optimal statistics from the ratios of variances and Studentized deviates. A particular form of multiple outlier detection is adopted. In the statistical testing, the null hypothesis is that the sample comes from a normal population, after necessary transformation; the alternative hypothesis can be one of three general types, with the population having a different type of distribution or a mixture of distributions or one in which there is slippage in the parameters. Inferences are conditional on the number of outliers and the alternate hypothesis. Application is made to 51 series of annual maximum flows from North America. Sixteen series are closely normal in distribution after deleting discordant values. Transformations are made to normality from assumed log-normal, and approximately from assumed gamma and log-gamma distributions. The Shapiro-Wilk goodness of fit test for normality is applicable under any alternate hypothesis. Ratios of variances and Studentized deviates give results of greater consistency than the other tests of discordancy when the distribution of outliers is unspecified or there is slippage in the parameters. Thick-tailed distributions can partly account for outliers. Another approach, which is exploratory, is to transform from an extreme value to an exponential type prior to detection; the exponential is the null distribution in this case. Methods of accommodating outliers in models for flood estimation are discussed. These will be examined further in a following publication. (Author's abstract)
W85-01171

LIMITATIONS ON SEASONAL SNOWMELT FORECAST ACCURACY

Washington Univ., Seattle, WA, Dept. opf Civil Engineering. D. P. Lettenmaier.
Journal of Water Resources Planning and Management, Vol. 110, No. 3, p. 255-269, July, 1984. 6 Fig., 2 Tab, 18 Ref., 1 Append.

Descriptors: *Snowmelt, *Runoff forecasting, Mountainous watersheds, Simulation, Mathematical models, Forecasting, Snow accumulation, Ablation, Conceptual models.

Forecasting of seasonal snowmelt runoff is an important exception to the otherwise limited accuracy of long-term runoff forecasts. Conceptual models of the snow accumulation and ablation and precipitation-runoff processes have been advocated as a means of introducing physical understanding of the dominant hydrologic processes into seasonal snowmelt runoff processes. However, the paucity of information and extreme spatial variability of meteorological processes and watershed characteristics in mountainous watersheds often result in large simulation errors. The analysis reported here relates monthly simulation error statistics to maximum achievable seasonal runoff forecast accuracy, presuming perfect knowledge of future (gage) precipitation and temperature, but without updating of model parameters or states. In some cases, this accuracy limit is less than that actually achievable using simpler models. The results suggest a preference for simple models if the coefficient of variation of monthly simulation error cannot be reduced below about 10-15%. (Author's abstract)
W85-01463

MAXIMUM CONTAMINANT LEVELS TOXIC SUBSTANCES IN WATER; A STATISTICAL APPROACH

Wisconsin Univ. Milwaukee, WI, Dept. of Urban Planning. G. W. Page and M. Greenberg.
Water Resources Bulletin, Vol. 18, No. 6, p. 955-963, December, 1982. 3 Fig., 6 Tab, 34 Ref.

Descriptors: *Water quality standards, *Statistical analysis, *Priority pollutants, Maximum contaminant levels, Standards, Carcinogens, Organic compounds, Pesticides, Cadmium, DDT, Above trace method, Ouliers, Trace levels, *Pollutant identification.

The above race Method proved more satisfactory for establishing maximum contaminant levels (MCL) or nondegradation standards for toxic substances in water than two other methods, the half minimum method and the log-normal method. It is based on statistical outlier procedures which distinguish ubiquitous background levels of toxic substances from concentrations significantly greater than background. The Above Trace Method does not make assumptions about the true concentration of samples which have trace or nondetectable levels. However, it failed to detect any outliers (therefore failed to estimate MCL) for 17 of 42 toxic organic chemicals. Pesticide results were also inconsistent. Using data obtained from analyses of water samples, the method can calculate a conservative interim MCL suitable for protecting the public until data based on human health studies are available. Since the period between carcinogen exposure and resulting cancer can be 20-30 years, it is likely that the human health statistics for the priority pollutants may not be available within 30 years. (Cassar-FRC)
W83-03145

METHODOLOGY FOR THE CHARACTERIZATION OF WATER QUALITY: ANALYSIS OF TIME-DEPENDENT VARIABILITY

Institut National de la Recherche Scientifique, Sainte-Foy (Quebec). M. Lachance and B. Bobee.
Journal of Hydrology, Vol. 59, No. 3-4, p. 275-291, November, 1982. 3 Fig., 2 Tab, 10 Ref.

Descriptors: *Water quality, *Model studies, *Evaluation, Saint Lawrence River, Aquatic life, Water supply.

The general methodology for characterization of water quality is presented and applied, after elimination of spatial effects, to the analysis of time dependent variability of physicochemical parameters measured on 18 dates during the summer months of 1976 at 12 sampling stations on the Saint Lawrence River between Cornwall and Quebec City. A transferable methodology is presented for characterizing water quality in relation to various uses. The method is based on the use of multivariate statistical methods suitable to the analysis of large data tables. The method is applied to the analysis of time dependent variability of water quality in two cases, namely domestic water supply purposes and ability of the environment to sustain balanced aquatic life. The analyses lead to an overall interpretation of this variability and to a description of the relations between parameters, the relative importance of parameter variations during the period of study, the relations between parameter values intervals and groups of sampling dates, and the behavior of the set of parameters connected to a given use at different dates. The methodology may also be transferred to a river or a given watershed if multiple uses are considered at the same moment. (Baker-IVI)
W84-05342

MODELING OF HYDROLOGIC PROCESSES IN A SMALL URBANIZED HILLSLOPE BASIN WITH COMMENTS ON THE EFFECTS OF URBANIZATION

Tokyo Univ. (Japan). Dept. of Civil Engineering. Y. Ando, K. Musiake, and Y. Takahasi.
Journal of Hydrology, Vol. 68, p. 61-63, 1984. 16 Fig., 6 Tab, 3 Ref.

Descriptors: *Hydrologic models, *Urban runoff, *Urbanization, *Urban hydrology, Urban drainage, Urban watersheds, Rainfall, Evaporation, Groundwater movement, Groundwater recharge, Impervious area, Tokyo, Japan.

A clarification of the hydrologic processes was developed based on a study off a small urbanized experimental basin in the Tama hills in the western suburbs of Tokyo, Japan. Impervious areas such as roofs and roads contribute to direct runoff. Infiltration areas do not contribute to direct runoff. Groundwater flow derives from the unconfined aquifer, and is in proportion to the second power of groundwater storage. Groundwater recharge is in proportion to soil-moisture excess. Evapotranspiration in the infiltration area of the urban basin is the same as that in the infiltration area of the urban basin is the same as that in the infiltration area of the natural basin, but the evaporation in the impervious area of the urban basin occurs to the extent of 2mm accompanied by rainfall. There were also urbanization effects on hydrologic processes. The contributing area to direct runoff is the saturated area for the natural basin, as against the impervious area for the urbanized basin. Urbanization effects on groundwater runoff are relatively small. Decrease in the ratio of the infiltration area to the catchment area, due to urbanization, has a large effect on the groundwater recharge process. Urbanization decreases evapotranspiration. (Murphy-IVI)
W84-03337

MODELING OF WATER FLOW AND SOLUTE TRANSPORT IN UNSATURATED HETEROGENEOUS FIELDS

E. Bresler, G. Dagan, (Volcani Center, Bet Dagan, Israel).
September, 1982. NTIS, PC A15/MF A01 – GPO $9.00. Order Number DE83001612.
From Symposium on unsaturated flow and transport modeling; Seattle, WA, USA (23 March 1982).
Portions are illegible in microfiche products.

A comprehensive model which considers dispersive solute transport, nonsteady moisture flow regimes and complex boundary conditions is described. The main assumptions are: vertical flow; spatial variability which is associated with the saturated hydraulic conductivity K_g occurs in the horizontal plane, but is constant in the profile, and has a lognormal probability distribution function (PDF); deterministic recharge and solute concentration are applied during infiltration; the soil is at uniform water content and salt concentration prior to infiltration. The problem is to solve, for arbitrary K_g, the Richards' equation of flow simultaneously with the diffusion-convection equation for salt transport, with the boundary and initial conditions appropriate to infiltration-redistribution. Once this is achieved, the expectation and variance of various quantities of interest (solute concentration, moisture content) are obtained by using the statistical averaging procedure and the given PDF of K_g. Since the solution of Richards' equation for the infiltration-redistribution cycle is extremely difficult (for a given K_g), an approximate solution is derived by using the concept of piston flow type wetting fronts. Similarly, accurate numerical solutions are used as input for the same statistical averaging procedure. The stochastic model is applied to two spatially variable soils by using both accurate numerical solutions and the simplified water and salt transport models. A comparison between the results shows that the approximate simplified models lead to quite accurate values of the expectations and variances of the flow variables for the entire field. It is suggested that in spatially variable fields, stochastic modeling represents the actual flow phenomena realistically, and provides the main statistical moments by using simplified flow models which can be used with confidence in applications.

MODELING OF WATER QUANTITY AND QUALITY FOR RIVER BASIN PLANNING

New Hampshire Univ., Durham, NH, Water Resources Research Center. S. L. Dingman.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84163179, Price codes: A05 in paper copy, A01 in microfiche. Research Report 39, April, 1983. 78 p., 19 Fig., 2 Tab, 25 Ref., 3 Append., Project No. OWRT A-059-NH (2), Contract/Grant No. 14-34-0001-2131.

Descriptors: *River basins planning, Water quality, *Dissolved oxygen, *Phosphorus, *New Hampshire, Merrimack River, *Model studies, Water pollution sources. Nonpoint pollution sources, Water pollution effects.

The objective of this study was to develop and test a river-basin planning model incorporating the effects of point and non-point sources of pollution on water quality. The model simulates the quantity and quality relations in a river network under critical low-flow conditions, and incorporates precise and hydrologically sound definitions of demand and supply. Flow and water quality are modeled at use sites (municipalities or industrial locations) by simple equations that allow planners to evaluate the effects of a complete set of structural and non-structural alternatives for meeting future water demands. The model was used to compute critical dissolved-oxygen concentrations for the Merrimack River Basin in New Hampshire, and showed encouraging correspondence with measured values. Phosphorus is also an important water-quality constituent, and extensive field studies of the behavior of that element were carried out in southeastern New Hampshire to elucidate its behavior in stream networks. It was found that given stream reach acts as a source of phosphorus under some conditions and a sink under others. It appeared that a chemical-kinetic effect and the erosion and deposition of fine sediments largely controlled this behavior. The study has established the need for water-resource planning models, described the specific elements of such models, demonstrated the feasibility of developing and applying such models in New England, and identified specific areas where research will contribute to the improvement of planning models.
W84-04411

MULTIVARIATE STATISTICAL ANALYSES OF 94-HOUR SEDIMENT BIOASSAY AND CHEMISTRY DATA

Aqua Tech Environmental Consultants, Inc., Melmore, OH. R. A. Laskowski-Hoke and B. L. Prater.
Bulletin of Environmental Contamination and Toxicology, Vol. 33, No. 4, p. 400-409, October, 1984. 3 Tab, 19 Ref.

Descriptors: *Water analysis, *Lake Michigan, *Bioassay, *Chemical analysis, *Lake sediments, Water quality, Harbors, Lakes, Multivariate analysis.

As a result of increased concern over toxic substances in freshwater sediments, renewed interest has been focused on the importance of sediment quality and sediment-organism, sediment-water column interactions. An investigation began in 1977 in five harbors of Lake Michigan to determine if relationships existed between results of chemical and bioassay analyses. The canonical correlation analyses illustrated significant relationships between the bioassay and various chemistry data sets. As an analytical tool, it facilitated the identification of the most important variables in each of the chemistry data sets relative to the bioassay data and confirmed the results of the univarate analyses. The multivariate analyses also illustrated that the redundancy of the bioassay data set was greater than that of each of the chemistry data sets. Although direct cause and effect relationships between mortality of test organisms and concentrations of chemical parameters are not postulated, these results add credence to the potential for such relationships. (Baker-IVI)
W85-02777

NASH MODEL RELATION TO HORTON ORDER RATIOS

R. Rosso.
Water Resources Research, Vol. 20, No. 7, p. 914-920, July, 1984. 11 Fig., 3 Tab, 18 Ref.

Descriptors: *Hydrologic models, *Catchments, Model studies, Streamflow, Velocity, Rainfall-runoff relationships, Storms.

The Nash model of the instantaneous unit hydrograph (IUH) is parameterized in terms of Horton order ratios of a catchment on the basis of a geomorphologic model of catchment response. The shape parameter of the Nash model is dependent on Horton's numbers R sub-A, R sub-B, and R sub-L, of a catchment. Therefore catchment geomorphology can provide a synthesis of the shape of the hydrologic response. The scale parameter of the Nash model results to be a time varying character depending on both geomorphology and average streamflow velocity along the stream network. These two factors are taken separately into account. The assumption of a constant response function for a catchment is therefore related to the assumption of a constant time scale of the IUH for the Nash model of catchment response. Since the IUH can be a time-varying characteristic, both throughout the storm and for different storms, this variability could be accounted for by the variability of the time scale of the IUH. Therefore the time scale of the IUH could account for the variability of the hydrologic response for different storms and throughout a storm. When compared with traditional regression formulae, these findings can substantially improve the prediction capability of the Nash model for catchments where no direct rainfall runoff analysis can be performed. (Baker-IVI)
W85-02158

NONPARAMETRIC TESTS FOR TREND IN WATER QUALITY

Washington Univ. Seattle, WA. G. van Belle and J. P. Hughes.
Water Resources Research, Vol. 20, No. 1, p. 127-136, January, 1984. 2 Fig., 5 Tab, 22 Ref., 1 Append.

Descriptors: *Water quality, *Trend, *Statistical analysis, *Nonparametric tests, Data analysis, Seasonal variation, Errors.

Nonparametric tests for trends in water quality have been developed because the assumptions of classical parametric methods (i.e., normality, linearity, independence) are usually not met by typical water quality data. Additional idiosyncrasies of the data, such as missing values, censored data, and seasonality, compound the analysis problem. The nonparametric methods are more flexible and can handle these problems more easily. Two classes of procedures, intrablock methods (procedures that compute a statistic, such as Kendall's tau, for each block or season and then sum these to produce a single overall statistic), and aligned rank methods (procedures that remove the block effect from each datum, sum the data over blocks, and then create a statistic from these sums) are examined in detail. Aligned rank methods are asymptotically more powerful than intrablock methods, but intrablock methods are more adaptable. Procedures to analyze more general models, including multistation designs and models, which include a trend-season or trend-site interaction, are developed by using Kendall's tau and intrablock methods. For the analysis of data sets with missing values and multiple values per season values, some possible solutions are adjustment of season length by using a uniform site series consisting of summary statistics, discarding extra observations, filling in missing observations with estimated values, or considering data collected in the same season as tied and using a modified version of tau. The appropriate procedure will depend on the individual data set, but basic statistical concerns include retention of the properties of homoscedasiticy (equal residual errors) and independence. (Moore-IVI)
W84-03419

NONPARAMETRIC TREND TEST FOR SEASONAL DATA WITH SERIAL DEPENDENCE

Geological Survey, Reston, VA. R. M. Hirsch and J. R. Slack. Water Resources Research, Vol. 20, No. 6, p. 727-732, June, 1984. 2 Fig., 2 Tab, 17 Ref.

Descriptors: *Hydrologic data, *Statistical methods, *Trends, Seasonal variation, Nonnormality, Censoring, Serial dependence.

Statistical tests for monotonic trend in seasonal (e.g., monthly) hydrologic time series are commonly confounded by some of the following problems: nonnormal data, missing values, seasonality, censoring (detection limits), and serial dependence. An extension of the Mann-Kendall test for trend (designed for such data) is presented. Because the test is based entirely on ranks, it is robust against nonnormality and censoring. Seasonality and missing values present no theoretical or computational obstacles to its application. Monte Carlo experiments shows that, in terms of type I error, it is robust against serial correlation except when the data have strong long-term persistence (e.g., ARMA (1,1) monthly processes with phi > 0.6) or short records (ca 5 years). When there is no serial correlation, it is less powerful than a related simpler test which is not robust against serial correlation. (Author's abstract)
W85-01347

PREDICTING DAILY IRRIGATION PROJECT DIVERSIONS

Idaho Univ., Moscow, ID, Dept. of Agricultural Engineering. S. Kim, J. R. Busch, and K. H. Yoo.
Available from the National Technical Information Service, Springfield, VA 22161 as PB84-111855. Price codes: A05 in paper copy A01 in microfiche. Idaho Water and Energy Resources Research Institute Completion Report, Moscow, October 1983. 72 p., 13 Fig., 3 Tab, 20 Ref., 3 Append. OWRT A-074-IDA(1), 14-34-0001-2114.

Descriptors: Irrigation systems, *Irrigation districts, Water management, *Irrigation practices, Water demand. *Diversions, Prediction, *Idaho.

The purpose of the research was to develop and apply methods for predicting daily irrigation diversions. Two types of models were developed to effectively predict diversions one day in advance and were applied to two large irrigation projects located in southeastern Idaho. The types of procedures developed and tested were (1) physical, and (2) statistical procedures. In addition, variables related to predicting diversions were presented and their relationships described. The physical model developed was designed to accurately represent the physical processes of water conveyance and use in an irrigation system. Required inputs included crop consumptive use and irrigation efficiencies in conjunction with time variables such as irrigation interval, irrigation application time and traveling time in the system. Results from the physical model indicated that more data would be necessary for accurate predictions in addition to updating procedures to account for seasonal variations within the system and management. Statistical models were developed using multiple regression techniques. Required inputs included evapotranspiration, precipitation, weekly variation of water use, previous diversion, and dummy variables used to account for monthly and seasonal variations of soil moisture management. Predictions from the statistical model followed actual diversions quite closely for three irrigation seasons. It was concluded that the statistical models were superior to the physical modeling approach for predicting irrigation diversions.
W84-00045

PRELIMINARY ESTIMATES OF LOADS CARRIED BY RIVERS TO ESTUARIES AND COASTAL WATERS AROUND GREAT BRITAIN DERIVED FROM THE HARMONIZED MONITORING SCHEME

J. C. Rodda and G. N. Jones.
Journal of the Institution of Water Engineers and Scientists, Vol. 37, No. 6, p 529-538, December, 1983. 2 Fig., 3 Tab, 27 Ref.

Descriptors: *Estuaries, *Sediment transport, *Rivers, *Great Britain, Coastal waters, Land use, Water pollution sources, Industrial wastes, Sulfates, Nitrates, Zinc, Copper, Chloride, Orthophosphate, Cadmium, Lead.

Rivers carry a wide variety of materials in solution, in suspension, and by saltation. Some of this material originates from natural sources, the remainder is from sources dependent on man and his activities. Preliminary estimates are given of the loads of eight chemical determinands carried by the rivers draining Great Britain: chloride, nitrates, sulfate, orthophosphate, zinc, cadmium, lead, and copper. The loads of British rivers show considerable diversity, reflecting the relative abundance and heterogeneity of sources in the basins they drain. This diversity results from the wide variety of rock and soil types, together with the assortment of contrasting industrial, urban, and agricltural land use patterns which together create the distinctive scenery of the islands. Climate also causes natural variations of the flows of rivers to extend over four orders of magnitude. The distribution of sulfate loads is largely related to sources dependent on industry such as on mine drainage and on washout and deposition of atmospheric sulfur compounds emitted by thermal power stations. Uncertainties involved in the assessment of the loads of these determinands are noted. (Baker-IVI)
W84-04316

PROBABILITY MODEL OF STREAM QUALITY DUE TO RUNOFF

Manhattan Coll., Bronx, NY. Environmental Engineering and Science Graduate Program. D. M. DiToro.
Journal of Environmental Engineering, Vol. 110, No. 3, p. 607-628, June, 1984. 11 Fig., 4 Tab, 16 Ref., 2 Append.

Descriptors: *Runoff, *Water quality, *Streamflow, Model studies, Probability distribution, Path of pollutants, Dilution, Rapid Creek, Dakota.

Probabilistic water quality analysis starts with classical, deterministic, water quality models of fate of pollutants and overlays probability theory in such a way that the probability distribution of the relevant concentrations are computed. An effective approximate method has been found for computing the exceedence probability of a downstream concentration that results from simple dilution and lognormal concentrations and flows. The exact equations which include the possibility of concentration flow cross correlation are also derived and numerically evaluated. The formulas are checked using simulations and verified using runoff and stream data from Rapid Creek, South Dakota. These demonstrate both the applicability and power of the methodology in the evaluation of the impact of runoff on the water quality of streams. (Baker-IVI)
W85-00718

REGIONAL DETECTION OF CHANGE IN WATER QUALITY VARIABLES

Colorado State Univ. Fort Collins, CO, Dept. of Civil Engineering. R. W. Koch, T. G. Sanders, and H. J. Morel-Seytoux.
Water Resources Bulletin, Vol. 18, No. 5, p. 815-821, October, 1982. 6 Tab, 8 Ref, OWRT B-186-COLO, 14-34-0001-8069.

Descriptors: *Water quality, *Stochastic hydrology, *Variability, Statistical analysis, Hydrology, *Conductivity, *Colorado.

A method is suggested for detecting changes in the mean of hydrologic variables which have a random and stochastic nature. Adapted from a bivariate normal distribution theory, this technique forms variables (both dependent and independent) as weighted linear combinations of the mean values at a number of locations in a selected target (dependent and control (independent) area. Weighting factors are determined by a mathematical programming technique which minimizes the conditional coefficient of variation and in turn the number of observations required to detect a change of preselected magnitude in the mean of the target area. The method was applied to six Colorado river basins in two variations: (1) electrical conductivity data from three stations as the target and three stations as the control, and (2) electrical conductivity data as the target variable and annual discharge as the control. The method detected changes in the mean within a shorter time than traditional tests and was especially effective in cases of high variability and limited numbers of monitoring stations. (Cassar-FRC)
W83-03295

RELIABILITY OF CALIBRATION OF A MONTHLY RAINFALL-RUNOFF MODEL: THE SEMIARID CASE

Rhodes Univ., Grahamstown (South Africa). A. H. M. Gorgens.
Hydrological Sciences Journal, Vol. 28, No. 4, p. 485-498, December, 1983. 6 Fig., 4 Tab, 12 Ref.

Descriptors: *Rainfall-runoff relationships, *Semiarid lands, *Mathematical models, Streamflow, Ecca basin, South Africa, Precipitation, Surface water, Calibration.

A monthly conceptual rainfall-runoff model that enjoys fairly widespread use in South Africa was calibrated for each of 50 calibration samples of lengths 3-20 years, drawn from a synthetic 101-year semiarid streamflow time series generated with the Stanford Watershed Model. The ability of Pitman's model to reconstruct the original 101 years of monthly streamflow for each of the 50 calibrations was then examined against a set of statistics of monthly and annual streamflows. The variabilities of key model parameters associated with different lengths of calibration period were also investigated. It is well worthwhile to increase the calibration period to about 15 years in order to reduce errors in reconstructed flow statistics. Merely increasing the length of calibration period from 6 to 10 years may decrease the error in most regenerated flow statistics by 30-50%. A fair amount of variability in 'optimum' parameters, however, seems unavoidable, even at longer calibration periods, though this may also partly be due to imperfect model calibration. The effects of this variability are greatly attenuated in the reconstructed flow statistics due to parameter interdependence. (Author's abstract)
W84-02827

RIVER BASIN VALIDATION OF THE WATER QUALITY ASSESSMENT METHODOLOGY FOR SCREENING NONDESIGNATED AREAS: VOLUMES I AND II

Midwest Research Inst., Kansas City, MO. M. J. Davis, M. K. Snyder, and J. W. Nebgen.
Environmental Protection Agency Project summary EPA-600/S3-82-057, September 1982. p. 6, 3 Tab.

Descriptors: *Water quality, *Nutrients, *Model studies, *Soil erosion, *River basins, Estuaries, Watershed management, Simulation, Mathematical models, Pollution load.

Techniques for estimating diffuse nutrient loads and their water quality effects throughout large watersheds were tested under various field situations for a wide range of data availability circumstances, water quality parameters, and hydrologic-hydraulic conditions, in five river basins, including the Sandusky River in Ohio, the Chester and Patuxent Rivers in Maryland, and the Ware and Occoquan Rivers in Virginia. Obtaining sufficient data to operate the model was the biggest problem in applying the loading methodology to specific river basins. Given the inherent inaccuracy in the basic Universal Soil Loss Equation (USLE) approach, use of the national data base was justified, especially if supplemented with specific country cover (R) factors. Despite the inaccuracies resulting from the use of a national data base, two to three person weeks of effort per basin should produce useful inputs to water quality screening assessments. The loading methods and the water quality methods tested in this study were highly compatible and gave reasonably accurate predictions of instream, lake, and estuary water quality constituent concentrations. The river modeling methods are the most accurate followed by the techniques for estuaries and then improvements. Low flow, steady state conditions are better predicted than high flow, unsteady loading situations. Applying these techniques, the watershed management planner should be able to recommend appropriate actions to investigate pollutant problem areas more closely in specific watersheds. (Moore-SRC)
W83-02042

SENSITIVITY ANALYSIS OF A DRAINAGE SIMULATION MODEL

Iowa State Univ., Ames, IA, Dept. of Agricultural Engineering. R. S. Kanwar and H. P. Johnson.
Water Resources Bulletin, Vol. 20, No. 3, p. 339-342, June, 1984. 3 Fig., 1 Tab, 4 Ref.

Descriptors: *Simulation, *Computer models, *Sensitivity analysis, *Drainage, Hydrologic models, Soil-water-plant relationships, Nitrogen, Soil water.

The integration of various processes representing a hydrologic system with a model structure to account for the time and space variability of the hydrologic components is a major problem in computer simulation modeling. A sensitivity analysis of a computer model, simulating major water and nitrogen processes of a soil-water-plant-climatic system on an annual basis, was conducted to determine how the model reacts to the variations in selected hydrologic and nitrogen parameters. As major output variables, total subsurface drain volume and cumulative nitrate loss with subsurface drain water were selected for the sensitivity analysis. The sensitivity analysis has shown that model predictions are more sensitive to hydrologic processes and parameters than to nitrogen parameters. Initial soil moisture content in the soil profile has the largest effect on the drain flow volume, and nitrate losses with subsurface drainage water. Soil moisture characteristics need to be investigated throughly to provide better simulation values. (Moore-IVI)
W85-01373

SIMPLE METHOD FOR PREDICTING DRAINAGE FROM FIELD PLOTS

Griffith Univ., Nathan (Australia). School of Australian Environmental Studies. J. Y. Parlange.
Soil Science Society of America Journal, Vol. 46, No. 4, p. 887-888, July-August, 1982. 2 Ref.

Descriptors: *Mathematical equations, *Drainage patterns, *Surface tension, *Diffusion coefficient, *Soil water suction, Model studies, Mathematical models, Drainage, Surface drainage, Prediction, Soil water.

A simple method based on analytical solutions of Sisson et al (1980) for predicting drainage from field plots is proposed. The work of Sisson and colleagues assumes that gravity is primarily responsible for water movement during drainage and neglects the effects of diffusion. The neglect of surface tension effects may lead to significant errors near the soil surface. In the new equation, profiles at a given time are translated upwards by gamma cm (treated as a constant), where gamma depends on suction near the surface and the time is adjusted to conserve mass. These corrections bring the analytic and numerical solutions closer together. (Geiger-FRC)
W84-00187

SIMULATION OF RUNOFF FROM SNOWCOVERED HILLSLOPES

Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering A. O. Akan.
Water Resources Research, Vol. 20, No. 6, p. 707-713, June, 1984. 5 Fig., 1 Tab, 16 Ref.

Descriptors: *Snowmelt, *Mathematical models, *Runoff, *Simulation, Slopes, Thaw, Freezing, Heat conduction, Flow, Vapor diffusion, Diurnal variations.

Accurate evaluation of the quantity and timing of daily springtime runoff from snow-covered hillslopes is needed for many purposes, such as flood forecasting, water supply forecasting, and the design and operation of regulatory hydraulic structures. A physics-based mathematical model

of springtime runoff from snow-covered hillslopes is presented, which accounts for liquid water flow, heat conduction, and vapor diffusion simultaneously within a snow cover. Runoff from the unsaturated zone is coupled with a saturated basal flow. The physics-based approach is verified by testing the model with two sets of observed data. After reaching a state of ripeness, a snowpack will experience daytime thaw and nighttime freezing during the spring. In order to illustrate the mechanism of diurnal variations in a wet snowpack, the mathematical model was applied to a hypothetical snow-covered plot. Based on the hypothetical case, springtime diurnal changes are not restricted to a thin layer near the snow surface, but they may influence the entire depth of a wet snowpack. (Moore-IVI)
W85-01344

SOME ALGORITHMS FOR PARAMETER ESTIMATION IN WATER RESOURCES SYSTEMS

Louisiana State Univ., Baton Rouge, LA, Dept. of Mechanical Engineering. H. Sehitoglu.
Water Resources Research, Vol. 19, No. 5, p. 1193-1202, October, 1983. 9 Fig., 23 Ref.

Descriptors: *Mathematical models, *Parameter identification, Model studies, Simulation, Finite-element models.

Many of the existing parameter identification schemes employ off-line algorithms, and so cannot be used in real-time applications. The problem of on-line parameter identification in some water resources systems was successfully resolved by developing proportional and proportional plus integral type algorithms. Lyapunov's stability theorem was applied to obtain recursive adjustment equations. This approach guarantees the convergence of the identification process. The proposed algorithms can identify unknown parameters of linear and nonlinear models. The application of the method depends on the selection of several algorithmic variables, such as gain constraints, filter cutoff frequency, finite-element size, etc. Simulation studies indicated that the method is convergent for a wide range of gain values. The filter frequency usually affects the identification response time. Low values of the frequency result in sluggish output, whereas high values may produce undesirable large oscillations. In general, decreasing the finite-element size improves the final accuracy. To further enhance the accuracy, higher-order finite-element basis functions may be used in obtaining the finite-element models. (Moore-IVI)
W84-02763

STATISTICAL ANALYSIS OF LINE-SOURCE SPRINKLER EXPERIMENTS AND OTHER NONRANDOMIZED EXPERIMENTS USING MULTIVARIATE METHODS

Kansas State Univ., Manhattan, KS, Dept. of Statistics. D. E. Johnson, U. N. Chaudhuri, and E. T. Kanemasu.
Soil Science Society of America Journal, Vol. 47, No. 2, p. 309-312, March-April, 1983. 1 Fig., 3 Tab, 4 Ref.

Descriptors: *Statistical analysis, *Sprinkler irrigation, Crop yield, Multivariate analysis, Mathematical studies.

The line-source sprinkler system provides a continuous variable soil water gradient away from a water source. The system can be used effectively to study the effects of various levels of water applied on crops, and minimizes the amount of land required for such experiments. A recent paper suggested that there was no statistical test available for comparing the effects of irrigation level on yield because irrigation levels are often applied systematically without randomization. This paper shows how multivariate methods can be used to obtain an appropriate statistical test. The method can also be used for many other nonrandomized experiments. One such experiment occurs when readings on the same experimental unit are recorded at several different time periods. Another occurs when measurements are made on several different parts of the same plant, e.g. stem, leaf, etc. The methods provide tests for equal cultivar effects; irrigation effects, and also cultivar X irrigation level interaction. (Moore-IVI)
W84-01187

STATISTICAL METHOD FOR THE ESTIMATION OF TREND IN SALINITY IN THE RIVER MURRAY

Australian National Univ., Canberra. Dept. of Statistics. R. B. Cummingham and R. Morton.
Australian Journal of Soil Research, Vol. 21, No. 2, p. 123-132, 1983. 5 Fig., 2 Tab, 4 Ref.

Descriptors: *Salinity, *River Murray, *Australia, Chlorides, Water quality control, Statistical analysis, Estimating, Low flow.

A simple statistical model is presented for the analysis of salinity measurements. The model is illustrated in detail for chloride concentration determinations in the River Murray at Morgan, South Australia, over a period of 43 years. High salinity in the lower Murray waters poses many present and potential problems for agriculture, domestic and industrial users of the water. Small changes in water quality are often difficult to detect because of large variability in the data, particularly in the lower reaches of the River Murray, where the problem is most acute. Estimates of trend cannot be properly be interpreted unless there is an appropriate statistical model to account for this variability. A positive trend has occurred in the river over and above that associated with a decline in waterflow. Some insight into the form of the trend is provided by a moving average of the log-chloride concentration after allowing for waterflow effects. Despite such extensive data, the linear component of this trend is not precisely established, as is clear from the wide-confidence limits. (Baker-IVI)
W84-03876

STATISTICAL MODELS FOR WATER QUALITY REGULATION

Colorado State Univ., Fort Collins, CO, Dept. of Agricultural and Chemical Engineering. J. C. Loftis, R. C. Ward, and G. M. Smillie.

Journal of the Water Pollution Control Federation, Vol. 55, No. 8, p. 1098-1104, August, 1983. 1 Tab., 8 Ref. NSF grant PRA-7913073.

Descriptors: *Statistical models, *Water quality control, Water quality, Model studies, Mathematical studies, Probability distribution, Frequency distribution, Stationary process, Seasonal variations, Linear programming, Confidence intervals.

A few statistical methods, simple enough for immediate use by regulatory agencies, are summarized and demonstrated for use in interpreting water quality data in light of current stream standards. The specific statistical techniques include: unconditional probability distribution models, seasonal probability distribution models, linear regression models, and confidence intervals on probability models. The usefulness of models such as the linear regression models lies in their ability to distinguish between natural and artificial causal mechanisms governing water quality processes. All four of the methods may be used by regulatory agencies in an effort to evaluate the significance of water quality changes, particularly standards violations, with regard to the relative importance of natural impacts or artificial impacts on water quality. The choice of which to apply will depend on the individual situation. Each of the four can be applied by personnel with only a limited understanding of statistical theory and only small microcomputers or programmable calculators and needed to perform the required computations on a routine basis. Application of these methods and tools should greatly enhance the ability of routine, fixed-station monitoring to provide in an efficient manner the kind of information needed for implementing the Clean Water Act. (Baker-IVI)
W84-02577

STATISTICS OF SPECIES ABUNDANCE DISTRIBUTIONS IN MONITORING AQUATIC COMMUNITIES

Idaho Univ., Moscow, IA, Dept. of Forest Resources. B. Dennis.

Available from the National Technical Information Service, Springfield, VA 22161 as PB83-206821, Price codes: A03 in paper copy, A01 in microfiche. Idaho Water and Energy Resources Research Institute Completion Report, Moscow, March 1983. 21 p., 22 Ref. OWRT A-085-IDA(1), 14-34-0001-2114.

Descriptors: *Aquatic environment, *Aquatic populations, *Species abundance distributions, *Aquatic biological communities, *Statistical methods, Statistical models, Probability, Water pollution effects, Model studies.

Statistical procedures were established for using species abundance distributions for monitoring polution impacts in aquatic biological communities. The report synthesizes the statistical theory necessary for conducting inferences with community abundance data. Previous use of species abundance distributions by ecologists has relied on largely ad hoc analysis procedures. Instead, this report recommends: (1) the sampling distribution be fully specified, and (2) maximum likelihood (ML) techniques for parameter estimation be used. Two particular abundance distributions, the gamma and the lognormal, appear to be useful provided the above recommendations are followed. The so-called Canonical Hypothesis places restrictions on the parameter values for the gamma or lognormal models. This hypothesis can be explicitly tested for most data sets using the ML estimation techniques. Other hypotheses that can be tested with these techniques are: (1) goodness-of-fit, for evaluating the model's description of the data, (2) two-sample for comparing two communities, and (3) likelihood ratio, for testing simple vs. complex models.
W83-03035

TECHNIQUES FOR DETECTING TRENDS IN LAKE WATER QUALITY

Colorado State Univ., Fort Collins, CO, Dept. of Civil Engineering. R. H. Montgomery, and K. H. Reckhow.

Water Resources Bulletin, Vol. 20, No. 1, p. 43-52, February, 1984. 1 Fig., 3 Tab, 49 Ref. NOAA grant 03-78-B01-109.

Descriptors: *Lakes, *Water quality, *Trends, Statistical methods, Autocorrelation, Data Analysis.

Information on changes in water quality over time is important for water quality management. The use of statistical techniques to detect trends in water quality parameters has the potential to provide the quantitative information needed for water resources management and planning decisions. A trend detection method is presented that provides: hypothesis formulation, the statement of the problem to be tested; data preparation, the selection of water quality variable and data; data analysis, the exploratory data analysis techniques; and statistical test, the tests for detecting trends. The starting point for the use of trend detection techniques is the determination of water quality characteristics upon which proper management and planning decisions are to be based. These characteristics determine the variables and data chosen, and the formulation of the null and alternative hypotheses. The frequent presence of autocorrelation in lake data prohibits straightforward use of most statistical techniques, including regression, based on the violation of the independence assumption. The statistical tests for dependent data are suggested for use, almost exclusively, when dealing with lake systems. The method is utilized in a stepwise fashion and is presented in a nonstatistical manner to allow use by those not well versed in statistical theory. (Moore-IVI)
W84-04103

TESTS FOR DETECTING A SHIFT IN THE MEAN OF HYDROLOGICAL TIME SERIES

Royal Netherlands Meterological Inst., De Bilt. T. A. Buishand.
Journal of Hydrology, Vol. 73, No. 1/2, p. 51-69, July, 1984. 3 Fig., 2 Tab, 16 Ref.

Descriptors: *Hydrologic models, *Mathematical studies, time series analysis, Statistical methods, Rainfall-runoff relationships.

A practical problem in time series analysis of hydrological and meterological data is to find statistical techniques for testing for an abrupt change in the mean at an unknown time. Suitable techniques have been developed in the situation of a single time series. Attention is paid to the likelihood ratio statistic and to a Bayesian statistic. Critical values are derived for the latter. Testing for a systematic change in a linear regression model is discussed. Examples are presented of annual precipitation and runoff for the River Thames Basin above Teddington, England. Regression of streamflow data on precipitation data gives a variance reduction which improved the power of statistical tests. Another reason for using a regression relation between streamflow and precipitation is to eliminate serial correlation effects. (Baker-IVI)
W85-02458

THE THREE-PARAMETER INFILTRATION EQUATION

Griffith Univ., Nathan (Australia). School of Australian Environmental Studies. J. Y. Parlange, I. Lisle, R. D. Braddock, and R. E. Smith.
Soil Science, Vol. 133, No. 6, p. 337-341, June, 1982. 1 Fig., 2 Tab, 12 Ref.

Descriptors: *Infiltration, *Soil water, Soil saturation, Sorption, *Conductivity, Equations.

An infiltration equation using a third parameter (alpha), related to soil conductivity, in addition to the usual sorptivity (S) and conductivity at saturation (K2), was developed to interpolate between two commonly-used two-parameter equations. The third parameter had nearly the same value for both soils tested: 0.8501 for clay and 0.8045 for sand. In practice, alpha may be given a value of 0.85 for most soils. This requires determination of only 2 parameters, sorptivity and conductivity. The three-parameter equation proved more accurate than both two-parameter equations and at least as accurate as Haverkamp's (1977) 6-parameter equation. (Cassar-FRC)
W83-00734

TREND ASSESSMENT OF WATER QUALITY TIME SERIES

A. I. McLeon, K. W. Hipel, and F. Comancho (Univ. of Western Ontario, London).
Water Resources Bulletin; No. 4, p. 537-547 (Aug. 1983).

A general methodology is described for identifying and statistically modeling trends which may be contained in water quality time series. A range of useful exploratory data analysis tools are suggested for discovering important patterns and statistical characteristics of the data such as trends caused by external interventions. To estimate the entries in an evenly spaced time series when data are available at irregular time intervals, a new procedure based upon seasonal adjustment is described. Intervention analysis is employed at the confirmatory data analysis stage to rigorously model changes in the mean levels of a series which are identified using exploratory data analysis techniques. Furthermore, intervention analysis can be utilized for estimating missing observations when they are not too numerous. The effects of cutting down a forest upon various water quality variables and also the consequences of acid rain upon the alkalinity in a stream provide illustrative applications which demonstrate the effectiveness of the methodology.

UNCERTAINTY ANALYSIS OF DISSOLVED OXYGEN MODEL

Villanova Univ., PA. Dept. of Civil Engineering. R. A. Chadderton, A. C. Miller, and A. J. McDonnell.
Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 108, No. EE5, p. 1003-1013, October, 1982. 7 Tab., 14 Ref.

Descriptors: *Dissolved oxygen, *Model studies, *Uncertainty analysis, Prediction, Estimating, *Streeter-Phelps equation, Mathematical equations, Mathematical studies, Streams, *Deoxygenation, Oxygen, Water quality, *Reaeration.

First-order uncertainty analysis was applied to 258 stream segments to determine the relative contributions to scatter or uncertainty in dissolved oxygen predictions by each of the parameters of the Streeter-Phelps equation. For very sluggish streams with reaeration rates less than about 0.1 per day, the most important parameters for dissolved oxygen predictions were the initial deficit and the deoxygenation rate constant. For streams having reaeration coefficients greater than 0.1 per day the most important parameter corresponded to the predominant aspect of the oxygen balancing mechanism for the stream segment. On the depletion portion of the dissolved oxygen sag curve, where deoxygenation exceeds reaeration, the deoxygenation rate constant contributed most of the uncertainty in dissolved oxygen prediction. However, on the recovery portion of the dissolved oxygen sag curve, where reaeration exceeded deoxygenation, the reaeration rate constant contributed most of the uncertainty in dissolved oxygen predictions. Application of the uncertainty analysis to identify critical water quality parameters for a given stream would lead to more efficient data collection efforts. (Baker-FRC)
W83-01961

UNIVARIATE VERSUS MULTIVARIATE RAINFALL STATISTICS — PROBLEMS AND POTENTIALS

Hanover Univ. (Germany, F.R.). Inst. fuer Wasserwirtschaft, Hydrologie, and Landwirtschaftlichen Wasserbau. W. Schilling.
Water Science and Technology, Vol. 16, No. 8/9, p. 139-146, 1984. 10 Fig., 3 Ref.

Descriptors: *Urban hydrology, *Rainfall, *Statistics, *Multivariate analysis, Mathematical studies, Design storms, Rainfall distribution.

Problems of conventional (univariate) rainfall statistics are discussed. Advanced problems in urban hydrology include design of detention reservoirs, computation of pollution loads and other features. For each of these tasks the conventional statistical treatment of rainfall data causes particular problems since hydrographs rather than peak flows are relevant for the final result. Implications of rainfall probability on probability of reservoir failure or pollution loads are extremely unreliable. Similar problems occur if a design storm is to be defined, because conventional rainfall statistics do not provide any rule how to order a sequence of rainfall intensities. A multivariate approach is presented which treats rainfall as a sequence of independent events, takes care of the temporal structure and eventually also takes care of the spatial structure of rainstorms. (Baker-IVI)
W85-01685

WATER QUALITY DATA EVALUATION STUDY (DOE/EV/10298--3, pp. VIII.1-VIII.14)

Megle, R. R. (Univ. of Colorado, Denver); Erickson, G. 1982. NTIS, PC A16/MF A01.

Oil shale environmental research and coordination. Progress report, 1979-1982.

The purpose of this study was to apply advanced data analysis techniques, capable of handling many variables simultaneously, to the large number of measurements of water constituents and physical characteristics from the Logan Wash area. Use of these data analysis techniques was prompted by the expectation that, because of the number and intermittent nature of the measurements, standard statistical techniques would fail to extract the significant relationships hidden in the data set. The advanced data analysis techniques used by Infometrix scientists in this study are specifically designed to address this type of problem. The approach used is referred to as Pattern Recognition. It is an iterative process between human analysts, having some knowledge of the problem at hand, and applied computer methods that can deal with many variables at the same time. The results of this approach are outlined. The data included measurements for up to 77 features on 700 water samples taken from 31 sampling sites in and around Retort 6 at Logan Wash on the edge of the Piceance Creek Basin region in Colorado, over a five year period from mid-1975 to early 1981. A sketch of the terrain contours and features with the approximate locations of the stream, bedrock and alluvial sampling sites is shown. The data studied were gathered by Occidental Oil Shale, Inc. (OXY), under a cooperative agreement with the Department of Energy. The major goals of the data analysis covered concerns such as determining baseline water chemistries, defining contamination and the affected areas, and examining analytical and experimental methods.

WATERSHED BOUNDED NETWORK MODEL (WBNM) FOR RUNOFF PREDICTION OF LARGE BASINS

Centre for Water Resources, Madras (India). K. Venugopal, T. V. Gopalakrishnan, and R. Sakthivadivel.
Nordic Hydrology, Vol. 14, No. 4, p. 229-238, 1983. 8 Fig., 2 Tab, 10 Ref.

Descriptors: *Watersheds, *Model studies, *Runoff forcasting, *Catchment areas, *Duck River, *North Carolina, Flood hydrographs, Hyetographs, Rainfall, Flood peak.

Applicability of a nonlinear version of the watershed bounded network model (WBNM) for large basins — namely Shelbyville (1,246 sq km), Columbia (3,129 sq km), Centreville (5,304 sq km) and Hurricane Mills (6,536 sq km) — of the Duck River basin (North Carolina) to predict flood hydrograph based on rainfall excess hyetograph was investigated using eight storm events. A WBNM was used that takes into account geomorphological and hydrological characteristics of the basin for conversion of rainfall excess to runoff and advocates division of the catchment into a number of sub-areas along the watershed lines, each representing a storage element, namely an ordered basin or an inter-basin area. Model parameter c was found to vary from basin to basin and in a given basin it varies with rainfall excess volume. For each model structure, the number of elements (sub-areas) were progressively reduced forming a combined sub-area of larger size. The time to peak (TPS), correlation coefficients (R), and the lag time (LAG) response measures determined from the predicted surface runoff hydrographs get stabilized beyond a minimum number of divisions. For the four catchments studied the minimum number of sub-areas required ranges from 10 to 20, with larger values required for bigger catchments. (Collier-IVI)
W85-01237

POLICY

BALANCING BENEFITS AND EXPENDITURE IN WATER POLLUTION CONTROL

C. Lefrou. Water Science and Technology, Vol. 14, No. 9-11, p. 1245-1255, 1982. 3 Fig., 29 Ref.

Descriptors: *Water pollution control, *Evaluation, *Economic aspects, Planning, Management, Water management, Decision making.

Variables existing in the different possible kinds of expenditures for the control of water pollution can fluctuate considerably within neighboring geographic areas for various reasons, such as the extent of water demand and the uses of the rivers by riparian owners. Expenditures include building, extension and maintenance of sewerage systems and urban sewage treatment works, sewerage construction in appropriate places, building industrial sewage treatment works and pretreatment facilities, removal of urban and industrial wastes to central disposal sites, laying out garbage dumps, treatment of rainwater in certain localities, and the maintenance of streams and their surroundings. Benefits derived from meeting these expenses include recreational benefits. diversionary uses, improved health, household benefits, industrial and commercial fisheries profits, and aesthetic benefits. Various methods of assessing the benefits provided by a pollution control policy are considered. (Baker-FRC).
W83-02862

CLEAN WATER ACT AMENDMENTS: NON-POINT SOURCE MANAGEMENT PROGRAM

Washington, D.C.; Government Printing Office (1983). 672 p.

Representative from a variety of industries, citizen groups, and environmental agencies and organizations testified for two days on the problem of regulating non-point source pollutants, including agricultural and urban runoff. The 35 witnesses were asked to address the extent and magnitude of the problem and to propose remedies. Additional statements and material submitted for the record follows each day's testimony. (DCK)

EFFLUENT STANDARDS FOR RECLAIMING INDUSTRIAL RIVERS

Yorkshire Water Authority (England). H. B. Tench. Water Science and Technology, Vol. 16, No. 5-7, p. 245-258, 1984. 2 Tab, 9 Ref.

Descriptors: *Water quality standards, *Rivers, *Industrial wastes, *Yorkshire, *England, Effluents, Biological oxygen demand, Suspended solids, Fisheries.

Wastewater from the high concentration of population and heavy industry can cause overload of relatively small rivers. Uniform emission standards for the discharges are inappropriate even in these areas as variations in river flows would make a uniform standard too relaxed or too stringent, according to circumstances, at different points. Provisional river water quality standards for commonly occurring toxic compounds are recommended which should enable self-sustaining coarse fisheries to be established in industrial rivers. Standards are also suggested which would improve the visual amenity of industrial rivers. These include a mean BOD no greater than 7 mg/l and a suspended solids of about 25 mg/l maximum expressed as a median to avoid the difficulties of interpretation of means. The toxic substances standards are expressed either as means or 95 percentiles for compounds which have a long or short time of effect respectively at their median lethal threshold concentration. These standards when tested against the river water qualities observed at various sampling points on Yorkshire (England) rivers give a broad indication of the presence or absence of fish, but they are not fully reliable in that some apparently satisfactory river reaches do not support a satisfactory fish population. A possible reason for this is that the intermittent discharges form storm sewage overflows are inadequately allowed for in the standards. (Moore-IVI).
W85-01405

INSTITUTIONAL, ARRANGEMENTS FOR CONTROLLING NONPOINT SOURCE WATER POLLUTION, WISCONSIN ROOF RIVER WATERSHED

Wisconsin Univ., Milwaukee, WI, Center for Great Lakes Studies. D. S. Sawicki and L. B. Judd. Available from the National Technical Information Service, Springfield, VA 22161 as PB83-150342, Price codes: A07 in paper copy, A01 in microfiche. Special Report No. 38, March 1982, 135 p., 6 Fig., 16 Tab, 29 Ref. OWRT C-00060-U (No 0484)(1).

Descriptors: *Water pollution control, *Nonpoint pollution sources, *Institutional constraints, *Decentralization, *Social aspects, Wisconsin, Regulations, Land use, Education, Economic aspects, Water quality, Institutions, Incentives, Voluntary actions.

A case study was made of a voluntary, decentralized institutional arrangement for managing nonpoint source water pollution control used in the Root River watershed in southeastern Wisconsin. The watershed was chosen because of its mix of urban, agricultural, and urbanizing land uses. The project objectives were: to monitor and draw conclusions about the effectiveness of a voluntary, decentralized institutional system; to specify deficiencies of the approach and suggest means to correct them; and to use the conclusions to speculate about the need for regulations regarding nonpoint source pollution control or the appropriateness of financial incentives for nonpoint source control. Institutional factors considered include: diversity of land uses in the watershed, educational needs, economic conditions, personality, water quality considerations, number of agen-

cies involved, definition of authority, and bureaucratic requirements. It was concluded that decentralization is desirable only when it serves a very clear, very important purpose. It is clearly inefficient and the problems related to it multiply rapidly as additional organizations and agencies are added. Use of a voluntary approach is largely a philosophical choice, and while it works for some practices, it is also inefficient. (Moore-SRC).
W83-01630

INTEGRATED RISK AND UNCERTAINTY ASSESSMENT IN WATER RESOURCES WITHIN A MULTI-OBJECTIVE FRAMEWORK

Case Inst. of Tech., Cleveland, OH. Center for Large Scale Systems and Policy Analysis. Y. Y. Haimes. Journal of Hydrology, Vol. 68, p. 405-417, 1984. 27 Ref.

Descriptors: *Water resources development, *Risks, Water management, Management, Decision making, Planning, Probability distribution.

The process of risk-and-uncertainty assessment in water resources in examined using a multi-objective framework. Appropriate methodologies such as the surrogate worth trade-off (SWT) method, the multi-objective statistical method (MSM), the partitioned multi-objective risk method (PMRM), the risk dispersion index method (RDIM), and the uncertainty sensitivity index method (USIM), are discussed briefly. A need for an approach that integrates the assessment of risk and uncertainty within a multi-objective framework is suggested, accounting for random variables with both known and unknown probability distributions. (Baker-IVI).
W84-03352

NONPOINT, SOURCE, POLLUTION CONTROL, A RESOURCE CONSERVATION PERSPECTIVE

Science and Education Administration, Tifton, GA. Southeast Watershed Research Center. W. G. Knisel, R. A. Leonard, and E. B. Oswald. Journal of Soil and Water Conservation, Vol. 37, No. 4, p. 169-199, July-August, 1982. 20 Ref.

Descriptors: Water resources development, *Soil conservation, *Erosion control, *Nonpoint pollution sources, Sediment erosion, Water pollution sources, Land management, Conservation, Pesticide drift, Watershed management, Water quality management, Agricultural runoff, Mississippi Delta.

Some aspects of the Federal Water pollution Control Acts Amendment of 1972 and the Soil and Water Resources Conservation Act of 1977 are in conflict with each other. Management practices are applied on farm fields for resource conservation, while nonpoint-source pollution control is often carried out on a much larger scale at some point in a stream system. Sediment has been identified as the major nonpoint-source pollutant. Erosion may be effectively controlled by conservation tillage, but the added pesticides required increase the chemical pollution of runoff. Grass or alfalfa buffer strips along channels or streams in the palouse of the Pacific Northwest are an effective means of reducing nonpoint pollution. Tillage of plots to reduce pesticide runoff in the Mississippi Delta area results in increased erosion, while overgrazing in the arid regions of the Southwest causes increased erosion and nonpoint source pollution by sediments. Some management practices recommended for soil conservation or improved water quality are discussed. Better criteria are needed for land use planners to determine what measures are required to meet the increasing demands of food production and environmental quality. (Geiger-FRC).
W83-00665

PRESERVING ILLUSIONS: THE CLEAN WATER ACT AFTER TEN YEARS

Peskin, H. M. Resources; No. 72, 12 (Feb 1983).

The 98th Congress is likely to vote without controversy to extend the 1972 Clean Water Act with only minor changes. The Act's uniform application of best pollution-control strategies has not burdened industry, which has averaged under two percent in annualized costs of most firms' sales. Local governments receive a 75% federal subsidy to lessen the pain of upgrading municipal treatment systems. Harder to explain is the environmentalists' approval of the Act. This may be because they place high value on doing one's best or are forced to rely on sketchy monitoring data and the system of permits that gives an appearance of tough action. Overall, the Act has not done much to improve the nation's waters since serious problems remain with pollution from agricultural and urban runoff, those areas where improvements were most needed.

PROXY VARIABLES FROM POLLUTION CONTROL

Iowa State Univ., Ames, IA, Center for Agricultural and Rural Development. D. R. Daines, Jr. and E. O. Heady. Journal of Environmental Quality, Vol. 12, No. 2, p. 203-208, April-June, 1983. 7 Tab, 8 Ref.

Descriptors: *Water pollution control, *Nonpoint pollution sources, *Soil management, *Farms, Soil erosion, Public policy, Texas, Economic aspects, Legal aspects.

Where the level of pollution from one farm cannot be reliably measured or estimated, environmental policies may be difficult to formulate and enforce. For this situation, a policy approach is suggested, which focuses on variables other than direct output of pollution. The use of proxy variables is illustrated in an analysis of alternative policies for controlling agricultural soil loss in the United States. As interregional programming model of U.S. agriculture is used to analyze and compare the proxy variable approach to direct limits and taxes on gross soil loss, with soil management practices employed as proxy variables. In achieving targeted soil loss reductions, the soil management practice policy would be less costly to society than a direct limit of

12.5 t/ha of soil loss, but a tax on each t of soil loss would be the least costly approach, assuming that soil loss could be easily quantified. (Author's abstract).
W84-01198

RESPONSIBILITY FOR RUNOFF CONTROL

Texas A and M Univ., College Station, TX, Dept. of Civil Engineering. E. J. Rhomberg, and J. M. Mason, Jr. Public Works, Vol. 113, No. 11, p. 60-62, November, 1982. 4 Ref.

Discriptors: *Storm water, *Runoff, *Legislation, Legal aspects, Urban runoff, Water quality control, Water pollution control, Flood control, Drainage districts, Drainage, History, Ordnances, Building codes, Water law, Natural flow doctrine, Reasonable use, Civil law, Common enemy rule.

Legislation concerning control of storm water runoff can be traced back to the Commerce Clause of the Constitution's first article, which, broadly interpreted, would have given Congress power to regulate any activity. Several laws proved unworkable with respect to storm water discharges: Rivers and Harbors Act of 1899, Public Health Service Act of 1912, the Oil Pollution Act of 1924, and the Federal Water Pollution Control Act (FWPCA) of 1948. Later legislation included amendments to the FCWPA in 1956 and 1961, the Water Quality Act in 1965, and the Clean Water Restoration Act of 1966. The National Environmental Policy Act of 1969 was a significant law. Its most important provision was the requirement for environmental impact statements. Further amendments to the FWPCA in 1972 and 1977 regulated discharges into all waters, not just navigable waters. Aid to municipalities was provided by the Flood Control Acts of 1938 and 1960. Early drainage laws were aimed at increasing the amount of arable land and eliminating waterborne diseases. More recent laws are also concerned with harmful effects on groundwater and wildlife. Existing rules on surface runoff drainage are the common enemy rule, natural flow rule (a.k.a. civil law rule), and the reasonable use rule. Municipalities have no duty to construct storm drainage systems, although some states have imposed this responsibility. Subdivision laws shift the requirement for storm drainage to the developer. Subsequent maintenance for the facilities is a subject of controversy. Municipal planning groups have considerable control over drainage through zoning and approval of development plants. Drainage districts, established as early as 1839, have powers varying with each state. Other forms of legislation affecting storm water runoff are zoning ordnances, building codes, and plumbing and sewer ordnances. (Cassar-FRC).
W83-02467

RISK-MANAGEMENT GUIDE (DOE/SSDC-76-45/11-Rev.1)

Briscoe, G. J. (EGG'S Idaho, Inc., Idaho Falls (USA)). Sep 1982. Contract AC07-761D01570. 226 p. (SSDC-11-Rev.1). NTIS, PC A11/MF A01. Order Number DE84000492.

The role of risk assessment is to provide the necessary information to make decisions regarding the cost effective commitment of resources to accident prevention and reduction. Risk assessment can also be used to determine if a proposed action is acceptable in those situations where it is impractical to eliminate particular hazards. A limitation in this process is that estimates of future losses are necessarily based on probabilities, statistics, and even subjective judgment; and therefore can never be precise. The decision to allocate resources, thus, is always made in the face of uncertainty. The purpose of risk analysis is to reduce that uncertainty as much as practical by providing a framework for the incorporation of all available information regarding the costs and risks of various alternatives. This guide provides some methods for analyzing and presenting this data to management.

SPECIATION: AN ESSENTIAL TOOL FOR THE ENVIRONMENTAL CONTROL FOR INORGANIC CHEMICALS IN WATER

Greenblatt, Greenblatt and Risenburger, Vineland, NJ. F. J. Riesenburger. Columbia Journal of Environmental Law, Vol. 9, No. 1, p. 63-74, 1983. 1 Fig., 41 Ref.

Descriptors: *Speciation, *Pollutant identification, Wastewater treatment, Water analysis, Legislation, Monitoring, Water pollution control.

The speciation procedures described make it possible to to qualitatively analyze compound forms and to quantify each different compound form. By accurately determining the water sites actually contaminated by the most hazardous inorganic or organic compound forms of an element, speciation could lead to a more effective allocation of funds for environmental control programs. Significant improvement of the environment by the use of speciation could also take place in other ways. Treatment methods implemented at existing water treatment plants are generally formulated on the basis of traditional bench scale analyses. Speciation could make possible the identification of certain compound forms which may not be responding optimally to such treatment methods. Introduction of a pretreatment or final polishing stage specifically addressed to the isolated problem compound form should increase significantly the efficiency of water treatment plants. Speciation could also provide a useful tool for the identification of the processors of certain chemicals found in surface waters, abandoned repositories and midnight dump sites. The EPA is currently reassessing the National Interim Primary Drinking Water Regulations, as the first step in the process of issuing new National Revised Primary Drinking Water Regulations. It is recommended that speciation be recognized by and incorporated into those regulations. (Baker-IVI).
W84-05046

SYSTEM THEORY FORMULATION OF SITE-SPECIFIC WATER QUALITY STANDARDS AND PROTOCOLS

Georgia Univ., Athens, GA, Dept. of Zoology. B. C. Patten. Ecological Modelling, Vol. 23, No. 14, p. 313-340, July, 1984. 6 Ref.

Descriptors: *Water quality standards, *Site specific standards, *Habitat variability, Decision making, Aquatic habitats, Standards, Toxicology, Systems analysis, Ecological effects, Water pollution effects.

The water bodies and wetlands of the United States host hundreds of ecological communities composed of thousands of interacting species, each with its own tolerances and preferences for physical and chemical factors of water quality. Habitat variability makes site-specific considerations a necessity in the specification of water quality standards. The U.S. Environmental Protection Agency (EPA) has recognized this in its development of procedures for site-specific modification of national standards. These procedures involve translation of laboratory toxicology data into field situations where such data are often poor predictors of biotoxicity. As formulated by the EPA, the site-specific problem was poorly specified. The legally defined objective of both National and Site-Specific Guidelines is to maintain the physical, chemical, and biological integrity of the environment. This can be framed in terms of general dynamical (state space) systems defined by a state transition function and a response (output) function. Development of site-specific environmental protection protocols must first involve finding a set of diagnostic variables whose maintenance within specifiable limits (standards) is both necessary and sufficient to protect all variables of a subject ecosystem. Standards for these variables must be determined through toxicity testing. Problems associated with determination of standards include: (a) spatiotemporal variability, (b) system linearity-nonlinearity, (c) system stationarity-nonstationarity, and (d) monitoring for baseline information, impact detection, compliance monitoring, establishment of causality, and prediction. Further efforts to develop a more practically oriented theory within the general system framework provided would be well advised; the present theory can serve to generally guide future methodological development. (Collier-IVI).
W85-02340

TRANSFERABLE DISCHARGE PERMITS ECONOMIC EFFICIENCY: THE FOX RIVER

O'Neil, W.; David, M. Moore, and C. Joeres, E. (Colby Coll., Waterville, ME). Journal of Environmental Economics and Management; 10: No. 4, p. 346-355 (Dec 1983).

Recent emphasis on reforms of environmental regulation has led to suggestions for strategies which maintain environmental standards but allow the needed flexibility and cost effectiveness. The transferable discharge permit (TDP) is one such strategy for water pollution control recently adopted in Wisconsin. In this article, the potential for substantial cost savings from trading TDPs is demonstrated using data on the Fox River in Wisconsin. A simulation model of water quality (Qual-III) and a linear programming model of abatement costs determine the optimum pattern of discharge. Reaching that optimum from proposed pollution abatement orders is shown to be feasible. Varying conditions of flow and temperature can be accurately estimated through interpolation. The calculations demonstrate the value and feasibility of flexible regulations governing water pollution abatement.

WATER QUALITY IMPACTS OF BIOCHEMICAL OXYGEN DEMAND UNDER TRANSFERABLE DISCHARGE PERMIT PROGRAMS

Illinois Univ. at Urbana-Champaign, IL, Dept. of Civil Engineering. E. D. Brill, Jr., J. W. Eheart, S. R. Kshirsagar, and B. J. Lence. Water Resources Research, Vol. 20, No. 4, p. 445-455, April, 1984. 11 Tab, 16 Ref.

Descriptors: *Water quality, *Biochemical oxygen demand, *Transferable discharge permits, Water quality management, Cost analysis, Dissolved oxygen, Water quality control, Williamette River, Delaware River estuary.

Biochemical oxygen demand is an important example of water pollutants that degrade biochemically and affect water quality according to the location as well as the strength of the discharge. Therefore, it is important to examine carefully the potential water quality impacts of a program of transferable discharge permits (TDP's) to regulate these discharges prior to the implementation of such a program. This paper provides a framework for evaluating these impacts and illustrates trade-offs among cost efficiency, equity, and uncertainty with respect to meeting water quality goals. Examples are given for the Delaware River estuary and the Williamette River. Violations of the standard could occur under a TDP program. Restrictions on the market could be used, however, to control or possibly to eliminate such violations. Limits on the total discharge in sections of the basin, zone boundaries for markets, and re-evaluation factors for transferred permits were effective individually or in various combinations. Even with these restrictions, however, there is sufficient flexibility so that significantly more cost-efficient solutions are obtained than under direct regulation programs that treat all discharges uniformly. (Murphy-IVI).
W84-04568

MISCELLANEOUS

A MARINE RECREATIONAL WATER QUALITY CRITERION CONSISTENT WITH INDICATOR CONCEPTS AND RISK ANALYSIS

V. J. Cabelli, A. P. Dufour, L. J. McCabe, and M. A. Levin. Journal of the Water Pollution Control Federation, Vol. 55, No. 10, p. 1306-1314, October, 1983. 3 Fig., 4 Tab, 37 Ref.

Descriptors: *Recreation, *Indicator organisms, *Water quality, Risk analysis, Risks, Human diseases, Public health, Fecal coliforms, Coliforms, Microorganisms, Enterococcus, Swimming, Marine environment.

The derivation of guidelines and standard based on acceptable risk for recreational water quality is explained. The two microbial guidelines or standards most commonly used in the U.S. are the total coliform limit of 1000/100 mL of water and the fecal coliform limit of 200/100 mL. The microbial guideline states that fecal coliforms should be used as the indicator organism for evaluating for microbiological suitability of recreational waters. Coliforms were rejected as the indicator of choice for evaluating sanitary conditions because of their variable correlation with fecal contamination. Ideally, recreational water quality indicators are microorganisms or chemicals whose densities or concentrations in the water can be quantitatively related to swimming-associated health hazards. One problem with the existing microbial guidelines for direct contact recreational waters is that they are not amendable to, or developed in the context of, risk analysis. They were derived from a barely detectable health effect rather than from exposure-response data. Therefore they do not allow for deliberate decisions by local, state, or federal officials about incremental decreases in the health risks involves. Rather, decision making is limited to acceptance or rejection of the specific limits. In a three year study of New York City beaches performed to determine which were the best indicators, the superiority of enterococci versus fecal coliforms was seen from the regression lines displayed on graphs of linear relationships between swimming-associated rates for gastrointestinal symptoms and mean enterococcus and fecal coliform densities in the water. Not only is this criterion more reliable because of the greater credibility of the information obtained, but also the consequences of the illness are more amendable to economic analysis. (Baker-IVI)
W84-02600

A STATISTICAL ANALYSIS OF THE QUALITY OF SURFACE WATER IN NEBRASKA

Geological Survey, Lincoln, NE., Water Resources Div., R. A. Engberg, Water-Supply Paper 2179, 1983. 252 p., 14 Fig., 9 Tab., 19 Ref.

Descriptors: *Water quality, *Surface water, *Chemical analysis, *Biological properties, Streamflow, River basins, Sampling, Sites, Water analysis, Regression analysis, Correlation analysis, Specific conductivity, Planning, Water quality control, *Nebraska.

This report provides descriptive statistics for 29 chemical or biological constituents for 109 stream sites in Nebraska sampled by the U.S. Geological Survey beginning in 1946. Also provided for each site are regression equations relating specific conductance to each of 12 chemical constituents and a regression equation relating specific conductance to stream discharge. The descriptive statistics are presented by river basins. Water leaving these basins that has the lowest mean specific conductance (266 umho/cm) is from the Niobrara River at Verdel, and water that has the highest (1,890 umho/cm) is from the South Platte River at Roscoe, Statewide, the principal cations in streamflow are calcium and sodium, and the principal anions are bicarbonate and sulfate. Calcium and bicarbonate usually predominate where the mean exceeds 1,000 umho/cm. Based on regression equations, dissolved solids, hardness, calcium, magnesium and bicarbonate, with some exceptions, correlate well with specific conductance for all stream sites. Illustrations of how regression equations may be used to estimate water quality of streamflow are given and are compared with values from actual analyses. (USGS)
W83-04014

AERIAL FLUX OF PARTICULATE HYDROCARBONS TO THE CHESAPEAKE BAY ESTUARY

Old Dominion Univ., Norfolk, VA., Dept. of Oceanography. B. Webber, Marine Pollution Bulletin, Vol. 14, No. 11, p. 416-421, 1983. 2 Fig., 1 Tab, 47 Ref. EPA grant X00322501.

Descriptors: *Particular matter, *Hydrocarbons, *Chesapeake Bay, *Estuaries, Deposition, Municipal wastewater, Water pollution, Air pollution effects, Fate of pollutants, Air pollution.

To delineate the magnitude of the atmospheric input of high molecular weight hydrocarbons, deposition rates were measured over a 15 month period at four stations in southeastern Virginia surrounding the lower Chesapeake Bay. A nearly linear trend of atmospheric particulate deposition was recorded. Deposition rates at the urban station (195 microg/sq m/day) were approximately three times greater than those recorded for nonurban and coastal locations (mean value 69 microg/sq m/day). The increased levels at the urban location were attributed to localized source inputs. Anthropogenic hydrocarbons accounted for approximately 50% of the total deposition at all stations. Significant biogenic inputs were indicated by the odd/even n-alkane distribution. A minimum flux to the water surface, based on mean nonurban deposition rates (24 mg/yr), indicated an annual particulate hydrocarbon flux of +275 metric tons. Little information is available for the comparison of additional source inputs; however, the data

reported here indicate that the aerial deposition of hydrocarbons is of the same order of magnitude as the input from municipal wastewater facilities and accidental discharge and is a potentially significant source of hydrocarbon pollution to the Chesapeake Bay Estuary. (Murphy-IVI)
W84-03544

AN APPROXIMATE PETROLEUM HYDROCARBON BUDGET FOR THE HUDSON RARITAN ESTUARY — NEW YORK

Connell, D. W. (State Univ. of New York of Stony Brook). Marine Pollution Bulletin; 13: No. 3, p. 89-93 (Mar 1982).

The quantities of petroleum hydrocarbons being discharged to the Hudson Raritan estuary have been estimated, in tons day, from data in the literature as: sewage discharges (35), oil refinery discharges (1.3), non-oil refinery industrial discharges (17), oil spills (1.5), atmospheric deposition (0.002), urban and rural run-off (37). Losses have been estimated in a somewhat similar manner as: permanent deposition in sediments (11), dredging (5.8), advection (6.5), bed sedimentary transport (0.007), decomposition in water and sediments (42), evaporation (0.4), movement of surface slicks (0.4). The results are approximate but suggest that petroleum hydrocarbons originate principally from sewage as well as urban and rural run-off and only moderate proportions are discharged through the estuary mouth. However, this discharge combined with that due to dredging spoil disposal operations results in a considerable quantity of petroleum hydrocarbon entering the adjacent New York Bight.

AVAILABILITY OF DISSOLVED OXYGEN IN INTERSTITIAL WATERS OF A SANDY CREEK

Indiana Univ., Northwest, Gary. R. L. Whitman, and W. J. Clark. Hydrobiologia, Vol. 93, p. 651-658, July 1982, 6 Fig., 1 Tab., 19 Ref.

Descriptors: *Interstitial water, *Dissolved oxygen, *Streams, *Mill Creek, *Texas, Conductivity, Alkalinity, Storm runoff, Convection, Base flow, Mixing, Thermal properties.

The chemical makeup of interstitial water is due to the combined influences of groundwater and surface waters. The possibility is examined of a thermally induced exchange mechanism for mixing of surface and subsurface waters in small, clean, sandy streams which display marked diurnal temperature fluctuations. Dissolved oxygen, pH, conductivity and alkalinity of surface and subsurface interstitial waters were investigated at Mill Creek (a small, rural, predominantly sandy stream in east Texas). Dissolved oxygen concentration tended to decrease with sediment depth, while conductivity and alkalinity did not significantly change with substrate depth. Surface water pH was significantly higher than interstitial water ($p = 0.05$). Chemical analyses of subsurface water from a pre- to post-storm event showed a depression in dissolved oxygen concentration in moderate and deep interstitial waters, immediately following the return of stream base flow, with the deeper strata returning to pre-storm oxygen levels four days later. A thermal convective current mechanism is proposed which would serve to transport surface water downward into these deeper interstices. The convective mechanism could influence the downward transport of organic material by helping to keep it in suspension. (Moore-IVI)
W85-02103

DOCUMENTATION OF A SAS PROGRAM TO CALCULATE WATER QUALITY INDICES

Olson, R. J. (Oak Ridge National Lab., TN (USA)). Nov 1984. Contract AC05-840R21400. 38 p., NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE85003542.

The Water Quality Index (WQI) program calculates use-impairment values at water quality monitoring stations to express the relative quality of surface water within a region. The method, as initially developed by EPA Region VIII staff, calculates an aggregated numeric index based on the exceedance of monitoring data for several parameters over established criteria values or water quality standards. The WQI program entails retrieving data from the EPA STORET system, processing the data with SAS programs, and mapping the WQI values. The report describes the processing steps, documents the SAS programs, and discusses concerns in acquiring input data and interpreting results. 1 Figure.

EFFECTS OF RUNOFF FROM UNDEVELOPED VERSUS LIGHTLY DEVELOPED WATERSHEDS ON TROPICAL PLANKTONIC ECOSYSTEM

Caribbean Research Inst., St. Thomas, VI. T. W. Purcell, III and M. J. Canoy. Technical Report No. 17, September 1983. 56 p., 2 Append. Project No. OWRT A-013-VI(1), Contract/Grant No. 14-34-0001-1150.

Descriptors: Runoff, Tropical waters, Plankton, *Marine water quality, Mangroves, *Virgin Islands, St. Thomas, Watershed development, Ecological impact, Water pollution control, Great Cruz Bay.

Two watersheds on the island of St. Thomas were studied to determine the effects of development on the quality of runoff water into the bays and to assess the effects of this runoff on the bay waters and plankton communities. The plankton communities studies were phytoplankton, zooplankton, and Ichthyoplankton. It was found that PO4 and NO3 were key nutrients, and turbidity a limiting physical effect. These, where they reached the bays, had a notable but not direct effect on the plankton production and dynamics. A key element in controlling the effect was whether or not the normal salt pond mangrove system was left intact.
W85-01810

EXPERIENCES WITH AUTOMATED INFORMATION RETRIEVAL

Vakgroep Gezondheidstechniek, Delft (Netherlands). Afdeling der Civiele Techniek H. H. Siebers and M. W. de Jong-Hofman. Water Research, Vol. 17, No. 12, p. 1715-1719, 1983. 6 Tab, 3 Ref.

Descriptors: *Information retrieval, Water supply, Wastewater treatment, Surface water, Information systems, Bibliographies.

There are two basically different ways to retrieve publications dealing with subjects in the field of water supply, wastewater treatment and surface water: manual and online. Manual searching contains, amongst others, reading professional journals and bibliographies or abstract journals. With the aid of a computer it is possible to search online in bibliographic data bases. This article mainly deals with online searching. In two practical examples results and expenses are put together. In order to execute a search as complete as possible online searching in several data bases is required. From the results of the searches and from reading the original literature, it is obvious that, if possible and done with special care, manual searching produces more references than online searching. (Author's abstract)
W84-02716

NONPOINT SOURCES

Johns Hopkins Univ., Baltimore, MD. Depart. of Geography and Environmental Engineering. M. G. Wolman and C. E. Chamberlin. In: Proceedings of the National Water Conference, Water Quality and The Clean Water Act, Philadelphia, January 26 and 27, 1982. Academy of Natural Sciences, Philadelphia, July 1982, p. 87-100, 16 Ref.

Descriptors: *Nonpoint pollution sources, *Pollution load, *Water pollution sources, *Water pollution effects, *Chemical wastes, *Pesticide toxicity, Water quality, Water quality data, Cost-benefit analysis, Public policy, Water policy, Water quality standards.

Pollutant discharges from both point and nonpoint sources affect the quality of rivers, lakes, estuaries, and ocean shorelines. In 1976 it was reported that after projected reductions of a variety of pollutants such as ultimate BOD, nitrogen, phosphorus, coliforms and several metals, in accord with requirements for BPT and secondary treatment by 1977, substantial loadings would remain for such pollutants as total nitrogen, phosphorus, and fecal coliforms. It was estimated that even after elimination of discharge, 79% of nitrogen, 53% of total phosphorous, 99% of coliforms, but only 11% of oil and grease would remain. The diversity of human activities and natural background across the country results in markedly different sources and characteristics of pollutants, with the result that uniform approaches will not achieve desired objectives. In general, it has been found that the organic content expressed as BOD and COD of runoff and discharges are generally comparable to concentrations found in effluents from secondary sewage treatment plants. Unit yields of sediment from construction sites may exceed previous background values 10 to 50-fold with concentrations on the order of 10,000 mg/1. For planning purposes, models are needed to compare the relative values of expenditures for control of diverse sources of pollutants to achieve given uses. (Garrison-Omni-plan)
W84-00916

PERCEIVED WATER QUALITY AND THE VALUE OF SEASONAL HOMES

Pennsylvania State Univ., University Park. Inst. for Research on Land and Water Resources. C. E. Young, Water Resources Bulletin, Vol. 20, No. 2, p. 163-166, April, 1984. 1 Tab, 9 Ref.

Descriptors: *Water pollution effects, *Property value, *St. Albans Bay, *Vermont, *Lake Champaign, Water quality.

St. Albans Bay is a large bay on Lake Champaign in northern Vermont. Recreational use of the bay has declined over time. A major reason for this decline is the deterioration in water quality. The impact of degraded water quality on the value of seasonal homes adjacent to St. Albans Bay is estimated using hedonic price functions. The value of properties located adjacent to the bay are depressed by about 20%, or $4,500 on average, compared with similar nearby properties on the larger but cleaner lake. Approximately 430 residential properties are located adjacent to St. Albans Bay. If the quality of water in the Bay were improved to a level perceived to be equivalent to the main lake. the total value of properties adjacent to the Bay would increase by about two million dollars. If the perceived improvement were only 50%, the water quality rating variable can be used to estimate the impact on property values. For a perceived improvement of 50%, the increase in property values would be $903,000. (Baker-IVI)
W84-05153

PESTICIDES IN GROUNDWATER BENEATH THE CENTRAL SAND PLAIN OF WISCONSIN

Wisconsin Univ. Madison, WI, Water Resources Center. J. M. Harkin, F. A. Jones, F. Fathulla, E. K.Dzantor, and E. J. O'Neil. Available from the National Technical Information Service, Springfield, VA 22161 as PB84-212272. Price codes: A04 in paper copy, A01 in microfiche. Technical Report No. WIS WRC 84-01, 1984. 46 p., 9 Fig., 5 Tab, 24 Ref. Project No. OWRT A-094-WIS(1), Contract/Grant No. 14-34-0001-2153.

Descriptors: *Agricultural chemicals, Groundwater, Groundwater movement, *Groundwater pollution, *Pesticides, Soil properties, *Wisconsin, Central Sand Plain, Path of pollutants, Water pollution sources.

Groundwater samples were collected periodically from monitoring wells and multilevel samplers installed in nine 160-acre fields in the Central Sand Plain of Wisconsin.

Potatoes were grown under irrigation in sandy soils over high water tables in each of these fields. All samples were tested for content of residues of aldicarb, a water-soluble systemic insecticide incorporated into soil once a year either with potatoes at planting at a rate of 3 lb/A or at shoot emergence at a rate of 1 lb/A. Regardless of application rate, timing or frequency (single or repeated applications in consecutive or alternate years) residues were found at some but not all locations tested within every field. Zones of contamination occurred only close to the water table and principally at locations where the soil and groundwater pH and alkalinity were low. As contaminated water sank with time to lower depths in the aquifer (10 to 12 feet below the water table), the concentrations of aldicarb residues fell dramatically or disappeared altogether, apparently as a result of alkali-catalyzed hydrolysis and bacterial metabolism superimposed upon physical dilution and dispersion. Samples of groundwater and aquifer sediments collected aseptically contained surprisingly high numbers of a large diversity of facultative anaerobic bacteria. These organisms can totally degrade aldicarb sulfoxide and aldicarb sulfone, the major metabolites of aldicarb which occur in groundwater, at a rate which suggests a half-life of about 1.3 years for aldicarb residues in Wisconsin groundwater.
W85-02025

PHYSICAL AND GEOCHEMICAL CHARACTERISTICS OF SUSPENDED SOLIDS, WILTON CREEK, ONTARIO

National Water Research Inst., Winnipeg (Manitoba), E. D. Ongley, M. C. Bynoe, and J. B. Percival. Hydrobiologia, Vol. 91, p. 41-57, July, 1982. 9 Fig., 1 Tab, 64 Ref.

Descriptors: *Wilton Creek, *Ontario, *Suspended solids, *Physicochemical properties, *Geochemistry, Storm runoff, Seasonal variation, Particle size, Calcium, Phosphorus, Magnesium, Aluminum, Titanium, Iron, Pottasium, Algae, Bioaccumulation.

To understand the nature of sediment-associated nutrient and contaminant transport dynamics in fluvial systems, a stormflow sampling program of suspended solids is reported for one water year in a representative rural diffuse source catchment of southeastern Ontario. Bulk samples of sub-sieve suspended solids were obtained using field-portable continuous-flow centrifuge apparatus. The physical and geochemical properties of suspended solids show no significant intersite differences over reaches of 1,500-2,000 m, yet display distinctive seasonal trends. Systematic seasonal changes in particle size, organic content, and Ca, P, Mn, Al, Ti, Fe, and K appear to reflect the changing role of partial area hydrology. Ca, P, and Mn are bioaccumulated by stream algae. Mineral signature is relatively constant over the year. (Author's abstract)
W85-02056

RECONNAISSANCE OF STORMWATER-RUNOFF WATER QUALITY OF THE BIG PINEY CREEK SEGMENT OF THE CEDAR-PINEY WATERSHED, YELL COUNTY, ARKANSAS

Geological Survey, Little Rock, AR., Water Resources Div., J. C. Peterson. Available from the OFSS, USGS Lakewood, CO 80224. Price: $2.75 in paper copy, $3.50 in microfiche, USGS Open-File Report 82-761, May 1982. 14 p., 1 Tab, 12 Ref.

Descriptors: *Water quality, *Small watersheds, *Storm runoff, *Nutrients, Coliforms, Streptococcus, Iron, Manganese, Sediments discharge, *Arkansas, Watershed reconnaisance.

A reconnaissance of the Big Piney Creek watershed was made between June 1981 and January 1982 to assess the water quality of selected streams in the watershed. Streamflow was measured and water samples were collected three times at each of three sites during the study. All samples were collected during periods of stormwater runoff. The water was soft (7 to 20 milligrams per liter of hardness as calcium carbonate) and dissolved-solids concentrations ranged from 36 to 74 milligrams per liter. Suspended-sediment concentrations ranged from 7 to 144 milligrams per liter. The 5-day biochemical oxygen-demands, total-nitrogen concentrations and total-phosphorus concentrations ranged from 1.5 to 6.8 milligrams per liter, 0.54 to 5.8 milligrams per liter, and 0.03 to 0.56 milligram per liter, respectively. Fecal-coliform bacteria were present in large enough concentrations at two of the sites (340 to 490 colonies per 0 milliliters and 1,200 to 6,000 colonies per 100 milliliters) to indicate that the U.S. Environmental Protection Agency criterion for bathing waters and the Arkansas water-quality standard may be exceeded at times. Total-iron concentrations grater than 1,000 micrograms per liter (the U.S. Environmental protection Agency criterion for production of freshwater aquatic life) were detected at least once at all sites. (USGS)
W84-00933

USE OF DIGITAL LAND-COVER DATA FROM THE LANDSAT SATELLITE IN ESTIMATING STREAMFLOW, CHARACTERISTICS IN THE CUMBERLAND PLATEAU OF TENNESSEE

Geological Survey, Nashville, TN. Water Resources Div., E. F. Hollyday and G. R. Hansen. USGS Water-Resources Investigations Report 82-4059, 45 p., 4 Fig., 9 Tab., 17 Ref.

Descriptors: Hydrology, *Remote sensing, *Watersheds (basins), *Hydrologic networks, Satellites, Terrain analysis, Floods, Low flow, *Tennessee, Cumberland Plateau, *Statistical analysis, Computer processing, Multi-spectral image analysis, Multiple linear regression.

Streamflow may be estimated with regression equations that relate streamflow characteristics to characteristics of the drainage basin. A statistical experiment was performed to

compare the accuracy of equations using basin characteristics derived from maps and climatological records (control group equations) with the accuracy of equations using basin characteristics derived from Landsat data as well as maps and climatological records (experimental group equations). Results show that when the equations in both groups are arranged into six flow categories, there is no substantial difference in accuracy between control group equations and experimental group equations for this particular site where drainage area accounts for more than 90 percent of the variance in all streamflow characteristics (except low flows and most annual peak logarithms). (USGS)
W84-03566

WATER DATA BANK (ARS) — UPDATE

Agriculture Research Service, Beltsville, MD., Water Data Lab., J. B. Burford, J. L. Thurman, and R. T. Roberts. Transactions of the American Society of Agricultural Engineers, Vol. 26, No. 4, p. 1142-1144, July-August, 1983. 8 Ref.

Descriptors: *Data collections, *Hydrological data, Data retrieval, Watersheds, Precipitation, Streamflow.

The USDA-ARS sponsors a continuing program of watershed hydrology research. The studies have involved about 600 individual watersheds. Data summaries have been published for about 500 of the watersheds and complete data files from about 300 watersheds are stored in the water data bank, maintained by the Water Data Laboratory. Data from about 925 precipitation stations associated with the watershed studies are also included in the data bank. Procedures used to obtain, standardize, store and retrieve hydrological data collected in conjunction with the various research projects are reviewed. Data user direct-access procedures are announced. (Baker-IVI)
W84-04459

WATER QUALITY MONITORING — RIVERS AND STREAMS, 1982

Indiana State Board of Health, Indianapolis, Div. of Water Pollution Control. Report, 1982. 138 p., 6 Tab.

Descriptors: *Water sampling, *Water analysis, *Water measurement, Water pollution, *Water pollution control, *Water pollution effects, Water quality management, Water quality, Biological samples, Chemical analysis, Chemical composition, State jurisdiction, Municipal water, *Indiana.

A program in Indiana to provide basic information on pollution trends and to provide water quality data for the state's surface water users has been described in annual water quality reports. This report, the 25th, emphasizes the importance of surface water via the fact that two-thirds of the water usage in Indiana in 1980 was obtained from surface supplies. While 49 sites were samples in 1952, 92 stations are included in the current program. Physical, chemical, and bacteriological analyses are made on samples collected from all 92 stations; plankton analyses from 18; and radiological analyses from 23. The forty-five methods of analyses used represent the minimum of bacteriological, chemical, and radiological analysis which would justify the collection program. The monitoring program is intended to indicate, when possible, the sources of pollution abatement programs, and to collect background data on certain types of waste, such as chlorides and radioactive materials. The monitoring stations are selected on the basis of having waters used for municipal, industrial, agricultural and recreational purposes; if they are near known or suspected sources of pollution; and when they are near state boundaries to determine the quality of water entering or leaving the state. Routine samples include 2,000 milliliters for chemical analysis and about 100 milliliters in a sterile bottle for bacteriological analysis. This year no flow data are included. (Garrison-Omniplan)
W84-00910

WATER QUALITY OF THE THREE MAJOR TRIBUTARIES TO THE CHESAPEAKE BAY, THE SUSQUEHANNA, POTOMAC, AND JAMES RIVERS, JANUARY 1979 — APRIL 1981

Geological Survey, Towson-Resources Investigations 82-32, May 1982, 64 p., 17 Fig., 20 Tab, 21 Ref.

Descriptors: *Water quality, *Data collections, *Water analysis, *Rivers, *Bays, Sampling, Sites, Storms, Stream discharge, Sediment transport, Sediments, Nutrients, Trace metals, Pesticides, *Chesapeake Bay, Susquehanna River, Potomac River, James River, Conowingo Dam, Fall Line.

Water-quality constituent loads at the Fall Line stations of the Susquehanna, Potomac, and James Rivers, the three major tributaries to the Chesapeake Bay, can be estimated with reasonable accuracy by regression techniques, especially for wet periods of 1 year of more. Net transport of all nutrient species and most other constituents is dominated by a few spring and storm-related highflow events. A trazine and 2,4-D are the two herbicides most consistently detected at the Fall Line of the Susquehanna and Potomac Rivers. Concentrations of total residual chlorine and low-molecular-weight, halogenated hydrocarbons at selected sites in estuaries to the upper Bay are generally at or below detection limits. Ammonia concentrations and loads are decreasing at all three Fall Line stations, as is orthophosphate in the Susquehanna and Potomac Rivers. Slight increases in total nitrogen and nitrite plus nitrate concentrations in the Susquehanna River from 1969 to 1980 may warrant continued monitoring. Analyses of data for this report confirm the previous suggestions that when water discharge of the Susquehanna River at Conowingo, Maryland, is below about 400,000 cubic feet per second sediment with sorbed nutrients and other constituents, is deposited behind the three hydroelectric dams on this river between Harrisburg, Pennsylvania, and its mouth. Discharges above 400,000 cubic feet per second resuspend these sediments and transport constituent loads to the Bay

well in excess of loads transported by the Susquehanna River at Harrisburg. (USGS)
W83-01847

WATER-QUALITY ASSESSMENT OF STEINER BRANCH BASIN LAFAYETTE COUNTY WISCONSIN

Geological Survey, Madison, WI. Water Resources Div. S. J. Field and R. A. Lidwin. Available from the national Technical Information Service, Springfield, VA 22161 as PB82-215757, Price codes: A04 in paper copy, A01 in microfiche. Water-Resources Investigations 81-52, March 1982. 58 p., 17 Fig., 21 Tab, 27 Ref.

Descriptors: *Water quality, *Agricultural watersheds, *Streamflow, *Stream discharge, Erosion, Nonpoint pollution sources, Path of pollutants, Suspended sediments, Sediment yield, Water temperature, Dissolved solids, Data collections, Sampling, Water analysis, Nutrients, Nitrogen, Phosphorus, Storm runoff, *Wisconsin, Lafayette County, Steiner Branch basin.

Steiner Branch basin in southwestern Wisconsin has rugged mature topography where few conservation practices are followed to reduce soil losses. This report assesses the magnitude and types of nonpoint discharges that affect the water quality of Steiner Branch. The 1978 water year discharge was about 90% of the average and the 1979 discharge was 120% of average. Streamflow during the 2-year study period ranged from 1.5 cubic feet per second, which is approximately the low flow that occurs on the average of once every 2 years, to 392 cubic feet per second, a discharge of about a 5-year flood-recurrence interval. Suspended-sediment yields were 369 tons per square mile in the 1978 water year and 84.6 tons per square mile in 1979. These yields were 1.66 times higher than those monitored in an adjoining basin where more typical conservation practices were employed. However, sediment discharge per unit of stream discharge was only 1.30 times higher in the Steiner Branch basin than in the adjoining basin. The estimated long-term annual suspended-sediment yield for the Steiner Branch basin in 444 tons per square mile. The majority of the nutrient load of the stream was transported during runoff events whereas transport of nitrite plus nitrate nitrogen and total nitrogen occurred primarily during baseflow conditions. (USGS)
W83-00123

APPENDIX

INFORMATION UTILITIES, DATA-BASE VENDORS, AND VALUE-ADDED NETWORKS

Many organizations within the Federal Government compile data about the environment and/or natural resources. As information technology develops, more and more of this data storage and retrieval is being performed with the aid of computers. The ease with which computer files can be updated, sorted, formatted, printed out in hard copy, and otherwise used makes this technique attractive for maintaining bibliographies of publications, time series of statistical data, historical values of calculated indexes, and other forms of information. Indeed, the pervasiveness and availability of these computerized information systems has led some observers to refer to such systems as information utilities akin to the gas, electric, and other utilities that serve our society.

The government puts these data bases to a wide variety of uses. Some are used to guide the day-to-day management and operation of federal projects and programs. And some statistics are gathered by the government specifically for the benefit of the private economy. It is probably safe to say that much of the information produced by the U. S. Government has applications outside the federal sector as well as within it.

It is the general policy of federal organizations to make the information they produce and compile publicly available whenever this can be done without endangering or damaging the interests of the nation, especially its security and sovereignty. However, government organizations are frequently designed to produce and compile data and to carry out some specified mission, not to respond to large numbers of requests for information. Federal agencies have dealt with this problem in a number of ways.

Agencies whose information is of interest to only a small clientel have frequently developed means to respond to requests for information on an individual basis. This can be seen from the descriptions of information services operated by federal agencies that appear in the main body of this publication. Oftentimes, requests for information are handled by the manager or researcher directly responsible for the compilation of the data sought, and copies of that data are provided directly to the private-sector user.

Other agencies routinely deposit their information in a centralized facility within their agency or in a joint clearinghouse, such as the National Technical Information Service. Indexes to the holdings of these depositories allow the user to find what is available in printed form and obtain it.

However, such direct responses and centralized depositories do not allow the user to personally access, manipulate, and research the computerized data files compiled by the Federal Government. To solve this problem, many agencies are trying to make their files more accessible to the private sector. How this is to be done has become the subject of a philosophical (and economic) debate. The crux of that debate is whether the distribution of government-produced and -compiled information is the Federal Government's province or the private sector's. The debate is probably still in its formative stages, and the technology that brought about that debate is still rapidly developing and expanding.

As things stand now, three approaches are being taken by the U.S. Government:

1. Many of the computerized data bases that the government compiles are being made publicly available through sale or lease to commercial enterprises. Because the lease of a large data base can cost tens of thousands of dollars per year, most of these private enterprises are data-base vendors who recoup their costs by selling access to the information to a worldwide clientel. Large corporations also purchase rights for in-house use of data bases.

2. Some of the computerized data bases (whose commercial appeal is, at best, uncertain) are being made directly available on government computers.

3. Other data bases are not being made directly available at all; only mediated access is being allowed to them.

In the main body of this publication are listed hundreds of data bases that contain government-supplied information and that can be accessed through commercial database vendors. These vendors purchase the data rights from the Federal Government either through the National Technical Information Service (NTIS) or directly from the federal agency producing the computerized files. The price is determined by the costs associated with collecting, analyzing, formatting, and processing the data into a machine-readable form. The vendors may also purchase specialized software for sorting, manipulating, and displaying the data. More often, though, the raw data are loaded onto the vendor's computer(s) in conjunction with the data-base-management software installed on that equipment. A relatively small number of the data bases listed above are accessed directly on federally owned computers.

The term "access" should not be construed to mean "cost free." The technology for maintaining computerized data bases is very expensive, and the costs of supporting that technology have to be borne by the user both in the private and public sectors. As a result, access to such data bases is usually controlled, use is recorded, and the user is billed for accrued charges.

Access is usually controlled with passwords. The potential user must apply to the appropriate data-base vendor for a password for that vendor's system. The vendor requires the applicant to fill out a registration form that states the financial responsibilities, rights, and duties of the user and declares the desired limitations on the use of the data base. Upon completion of the registration form (and sometimes the payment of a registration fee), a password is issued. That password is used by the patron to gain entry to the vendor's computer(s) and is used by the vendor to monitor usage and prepare billing accounts. Vendors frequently provide the fundamental instructions for using their systems free of charge and provide more detailed documentation on usage techniques for a fee. (The complete documentation for a full system can literally amount to hundreds of volumes; however, the normal user rarely needs more than the basic manuals.)

The user must connect with the vendor's computer system through a telecommunications link. The most common ways of doing this are through packet-switching networks, direct-dial telephone service (including inward-bound Wide-Area Telephone Service (WATTS)), telex, or a vendor's private communication network. In many circumstances, the telecommunication charges are paid by the vendor and backcharged to the user; thus the user receives a bid for a combination of computer-usage charges and telecommunication charges. Costs associated with these telecommunication services can vary widely depending on the relative locations of the user and the vendor. Some means of telecommunication might not be available in certain locations or for certain data-base vendors.

Special arrangements have to be made between a telecommunications service and data-base vendor before the vendor can be connected to the telecommunications system. Different vendors are served by different communications systems. Thus, potential users should refer to the promotional and technical literature of a data base vendor to learn how to make contact with the vendor's equipment.

The names and addresses of the data-base vendors that offer the data bases cited in the main body of this publication are as follows. More information about the data bases they carry, the services they offer, the equipment needed to use their systems, and the telecommunications networks they employ can be obtained directly from them.

AGNET
105 Miller Hall
University of Nebraska at Lincoln
Lincoln, Neb. 68583

American Management Systems
1777 North Kent St.
Arlington, VA 22209

Australian Medline
National Library of Australia
Parkes Pl.
Canberra ACT
Australia 2600

Battelle Columbus Laboratories
505 King Ave.
Columbus, Ohio 43201

BELINDIS
Belgian Ministry of Economic Affairs
Rue J.A. de Mot, 30
1040 Brussels, Belgium

Berkeley Solar Group
3140 Grove St.
Berkeley, Calif. 94703

BLAISE-LINK
The British Library
2 Sheraton St.
London, WIV 4BH
England

BNDO
BP 337
29273 Brest Cedex
France

Boeing Computer Services Co.
7980 Gallows Ct.
Vienna, Va. 22180

Bolt, Beranek, and Newman
10 Moulton St.
Cambridge, Mass. 02238

BRS
1200 Rt. 7
Latham, N.Y. 12110

Chase Econometrics/Interactive Data
486 Totten Pond Rd.
Waltham, Mass. 02154

CAS
American Chemical Society
P.O. Box 3012
Columbus, Ohio 43210

ChemShare
P.O. Box 1885
Houston, Tex. 77001

CiSiNetwork
PCS Div.
16625 Saticoy St.
Van Nuys, Calif. 91406

CISTI
National Research Council of Canada
Ottawa, Ontario KIA 0S2
Canada

Citishare
Box 1127
New York, N.Y. 10043

CompuServe
5000 Arlington Centre Blvd.
Columbus, Ohio 43220

The Computer Company
1905 Westmoreland St.
Richmond, Va. 23230

Computer Sciences Corp.
2100 East Grand Ave.
El Segundo, Calif. 90245

Comshare
P.O. Box 1588
3001 South State St.
Ann Arbor, Mich. 48106

Control Data Corp. Business
Information Services
500 West Putnam Ave.
Greenwich, Conn. 06836

Dartmouth College
Project IMPRESS
Hinman Box 6101
Hanover, N.H. 03755

DATA-STAR
Wiloughby Rd.
Bracknell, Berkshire RG124DW
England

Derwent
Stuart House
47 Crown St.
Reading, Berkshire RS1 2SG
England

DIALOG
3460 Hillview Ave.
Palo Alto, Calif. 94304

DIMDI
Weishausstrasse 27
P.O. Box 420580
D-5000 Cologne 41
Federal Republic of Germany

Dow Jones
P.O. Box 300
Princeton, N.J. 08540

DRI
Suite 1060
1750 K St., NW
Washington, D.C. 20006

Dan Bradstreet Computer Services
187 Danbury Rd.
Wilton, Conn. 06897

European Space Agency
ESPRIN
Via Galileo Galilei
0044 Frascati
Italy

General Electric Information Services
401 North Washington St.
Rockville, MD 20850

GID-SIT
Herriotstrasse 5
Postfach 710370
D-6000 Frankfurt am Main
Federal Republic of Germany

Honeywell DATANETWORK
6400 France Ave., South
Edina, Minn. 55435

Hydrocomp, Inc.
201 San Antonio Cir.
Mountain View, Calif. 94040

I.P. Sharp
Box 418
Exchange Tower
2 First Canadian PL
Toronto, Ontario M4X 1E3
Canada

IAEA
P.O. Box 100
A-1400 Vienna
Austria

INKA Karlsruhe
D-7514 Eggenstein-Leopoldshafen 2
Federal Republic of Germany

International Research and Evaluation
21098 IRE Control Ctr.
Eagen, Minn. 55121

ISI
3501 Market St.
University City Science Ctr.
Philadelphia, Penn. 19104

Japan Information Center of Science and Technology
5-2, 2-Tyome
Nagatatyo, Tiyoda-Ku
Tokyo 100
Japan

Japan Information Processing Service
6-7 Nihon Bashi Kabutocho
Chuo-Ku
Tokyo 103
Japan

Medical Information Center
P.O. Box 60201
S-104 01 Stockholm
Sweden

National Library of Medicine
8600 Rockville Pike
Bethesda, Md. 20209

NewsNet
945 Haverford Rd.
Bryn Mawr, Penn. 19010

NIH/EPA Chemical Information System
USEAP CIS Project
PM-218
401 M St., SW
Washington, D.C. 20460

Occupational Health Services
515 Madison Ave.
New York, N.Y. 10022

On-Line Research
200 Railroad Ave.
Greenwich, Conn. 06830

Pergamon-InfoLine
12 Vandy St.
London EC2A 2DE
England

Petroleum Information Corp.
P.O. Box 1702
Houston, Tex. 77251

QL Systems
Suite 1018, Tower B
112 Kent St.
Ottowa, Ontario K1P 5P2
Canada

Rapidata Div. of National Data Corp.
20 New Dutch Ln.
Fairfield, N.J. 07006

SAGE DATA
104 Carnegie Ctr.
Princeton, N.J. 08540

Scicon
Brick Close, Kiln Farm
Milton Keyes MK11 3EJ
England

SDC/ORBIT
2500 Colorado Ave.
Santa Monica, Calif. 94103

Spidel
98, Boulevard Victor Hugo
92115 Clichy
France

STSC
2115 East Jefferson St.
Rockville, Md. 20852

Syracuse Research Corp.
Merrill Ln.
Syracuse, N.Y. 13210

Telesystemes-Questel
40, rue du Cherche Midi
75006 Paris
France

Tymeshare
20705 Valley Green Dr.
Cupertino, Calif. 95014

Uni-Coll
3401 Science Ctr.
Philadelphia, Penn. 19194

United Information Services
P.O. Box 8551
Kansas City, Mo. 64114

University Computing Co.
1930 Hiline Dr.
Dallas, Tex. 75207

USDOE Bartlesville ETC
P.O. Box 1398
Bartlesville, Okla. 74003

USEAP
National Air Data Branch
MD-14
Research Triangle Park, N.C. 27711

U.S. Fish and Wildlife Service
Western Energy and Land Use Team
2627 Redwing Rd.
Ft. Collins, Colo. 80526

U.S. Geological Survey
421 National Center
Reston, Va. 22092

Weather Services International Corp.
131 The Great Road
Bedford, Mass. 01730

Weatherscan International
2445 NW 39th Expressway
Oklahoma City, Okla. 73112